FERTILIZERS AND MANURES

Instructional-cum-Practical Manual

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राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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FOREWORD

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth.

In view of the importance of the programme the NCERT is making an all out effort to provide academic support to the implementing agencies in the States. One of the major contributions of NCERT is in the field of curriculum development and in the development of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational course are involved. These materials are then sent for try-out in schools and feedback is collected through questionnaires and through direct contact. The materials are also sent to experts for comment before they are published.

The present manual on **Fertilizers and Manures** has been developed in the manner described above and is meant for the students studying Crop Production and allied vocations. It is being published for wider dissemination amongst students and teachers throughout the country. I hope that they will find the manual useful.

I am grateful to all those who have contributed to the development of this manual. I must acknowledge also the immense interest taken by Prof. A.K. Mishra, Head, Department of Vocationalization of Education in inspiring his colleagues in their endeavours to develop instructional materials. Dr. A.K. Sacheti, Reader, functioned as the Project Coordinator for the development of this title in association with Dr. A.K. Dhote, Lecturer. They have my appreciation and thanks for planning, designing and conducting

the workshops, for technical editing and for seeing this manual through the Press.

Suggestions for improvement of this manual will be welcome.

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October, 1985

PREFACE

Ever since the introduction of vocationalization in our school system by several States and Union Territories in our country the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship of pupils offering vocational studies at the higher secondary stage.

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi has started a modest programme of developing instructional materials of diverse types to fill-up this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a Working Group of experts constituted by NCERT.

The present manual is on **Fertilizers and Manures** and is meant for the pupils and the teachers teaching Crop Production and allied Vocations being offered in a number of States. It contains activities (Practical exercises) to be performed by pupils with simple steps to follow, precautions to be taken and data to be obtained and processed. Each activity is complete with objectives, relevant information, behavioural outcomes, evaluation, etc. It is hoped that the users will find them immensely useful.

The experimental edition of the manual was developed by a group of experts as contributors in a workshop held at the Directorate of Extension Education, University of Udaipur, Udaipur, Rajasthan. The same was later circulated to receive the feedback from the user pupils and teachers in the States of Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra. After a period of one year for the try-out, the feedback was received and accordingly the experimental edition was suitably reviewed and revised through a committee of experts in a workshop held at the University of Agricultural Sciences, Hebbal, Bangalore. The names of the contributors and reviewers are

mentioned elsewhere and their contributions are admirably acknowledged. We are grateful to all the institutions, students and teachers who have used the manual and sent their comments. Dr. A.K. Sacheti, Reader and Co-ordinator of this Project and Dr. A.K. Dhote, Lecturer, Department of Vocationalization of Education deserve special thanks for editing and bringing the manual in the present form. The assistance of all in the University of Udaipur, Udaipur, Rajasthan; the University of Agricultural Sciences, Hebbal, Bangalore and the Deparment of Vocationalization of Education, NCERT is also thankfully acknowledged.

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October, 1985

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ABOUT THE MANUAL

Under the programme of Vocationalization of Education about 20 different groups of vocational courses in the area of agriculture have been introduced by nine States and three Union Territories so far. These courses have been running for the last six or seven years. From the very beginning the Department of Vocationalization of Education in the NCERT has been working hand in hand with the State organisations concerned, through various programmes organised for State officials, vocational teachers, and others. In fact, by now the Department has conducted on-the-spot studies of vocational programme in large number of States, to find out merits and demerits of the programme and to suggest appropriate measure to resolve the problems in 'vocational agriculture education'. These programmes have revealed that there was a great dearth of suitable textual/instructional materials; the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of education programme has been launched. The main aim of the programme is to prepare the pupil for purposeful and gainful employment (wage-earning or self-employment).

The Department constituted a Working Group during the year 1982 to formulate guidelines for developing models for a variety of instructional materials.

Based on the guidelines formulated by the Working Group, Crop Production, which is an important and popular vocational course in agriculture, was selected by the Department for the purpose of development of instructional materials in a phased manner. To begin with, the development of instructional-cum-practical manuals has been taken up.

The content of Crop Production and similar courses offered by the States and Union Territories under different titles was thoroughly analysed and it was felt that seven manuals would be necessary to cater to the needs of the course. The present manual on **Fertilizers**

and Manures is one of them. This manual is intended to help both teachers and pupils in the study of fertilizers and manures and their application as preparation for this vocation. While developing the manual, care was taken that it should include the maximum number of Activity Units (practical exercises) so that it can fulfil the requirements of the course prescribed by the States and Union Territories in the Crop Production as well as in other vocational courses.

These Activity Units are essential to develop the required vocational skills in the pupils. The manual explains in detail the 'what', 'why', and 'how' of these Units.

In the manual each Activity Unit has been dealt with under several sub-heads, *viz.*, instructional objectives, relevant information, precautions, materials required, procedure, observations, expected behavioural outcomes and questions.

Before commencing the actual work under any Activity Unit, the teacher should know what exactly the pupils have to learn and do, and should also assess whether they will be able to do that. Therefore, in the beginning, instructional objectives for the pupils should be framed in behavioural terms by the teacher.

In order to acquaint the pupils with the Activity Unit the teacher should provide them with the required theoretical knowledge or information relevant to the activity. This will help the pupils to properly understand the Activity Unit. In other words, the 'what' and 'why' parts of the Activity Unit should be explained in advance by the teacher.

Once the pupils have understood the relevant theoretical instructions, the teacher should tell them about the precautions which are to be taken before and during the actual execution of the Activity Unit. This will facilitate smooth working. The 'how' part of the Activity should be explained by the teacher in the 'procedure' which pupil should follow while performing the Activity Unit.

Under the sub-head 'observations', the teacher should tell what to observe and in view of that the pupil should observe the situation, take readings, note down the temperature and similar other points, under each Unit; these may vary from Unit to Unit. Wherever calculations are required to be done to obtain the results, this should also be indicated under this head or under separate head.

At the end of the Activity the pupil will have acquired certain abilities which should be closely related with the instructional objectives formulated for each Activity Unit. These abilities should

done by the teacher concerned.

For evaluating each aspect, the teacher will use a four-point scale, i.e., A, B, C & D, and for each Activity Unit the Grade Point Average can be calculated as indicated below :

Suppose there are four aspects, each carrying equal weightage, and a pupil obtains 2A's, 1C and 1D and if A = 4 point, B=3, C=2 and D=1 point; then, based on the grades, the pupil will get 11 points. When the number of points obtained is divided by the total number of aspects examined, it will give the Grade Point Average, which, in this case, is 2.75. The tabular presentation is as under :

Aspects	*Weightage*	*Grades Obtained*	*TOTAL POINTS (weightage × point-equivalent to grade obtained)*	*Grade Point Average*
1	1	A	1 × 4 = 4	
2	1	C	1 × 2 = 2	= 11/4 = 2.75
3	1	D	1 × 1 = 1	
4	1	A	1 × 4 = 4	
			11	

At the end of the Activity Unit, some questions relevant to it are also given. The pupils should write the appropriate answers after the completion of the Activity Unit and teacher should examine them. If required, he should make suitable corrections and give suggestions. However, answers to these questions will not be considered for the purpose of grading.

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Appendix

INTRODUCTION

Besides light, temperature, mechanical support, water and air, there are certain elements which are essential for the normal growth of plants (Fig. 1). An element is considered as essential plant nutrient because:

- the plant is unable to grow normally or complete its life cycle in the absence of the nutrient;
- it plays a direct role in the metabolism of the plant;
- it is specific for its function and cannot be replaced by another element.

These elements are sixteen in number. A few others like silicon, sodium, selenium and cobalt are also required by some plants. Some of them are drawn by the plants from air and water and others are absorbed from the soil. A list of sixteen elements along with their source and nature (Primary Secondary, Macro/Micro) is given below:

Source	Elements		Nature
1. Air & water	Carbon		
	Hydrogen		
	Oxygen		
2. Soil	Nitrogen	Primary	Macro elements required in large amounts
	Phosphorus		
	Potassium		
	Calcium	Secondary	
	Magnesium		
	Sulphur		
	Iron		Micro elements required in small amounts
	Manganese		
	Copper		
	Zinc		
	Boron		
	Molybdenum		
	Chlorine		

Availability of all plant nutrients/elements in an optimum concentration is essential for the normal growth and development of plants. Generally carbon, oxygen and hydrogen are taken from air

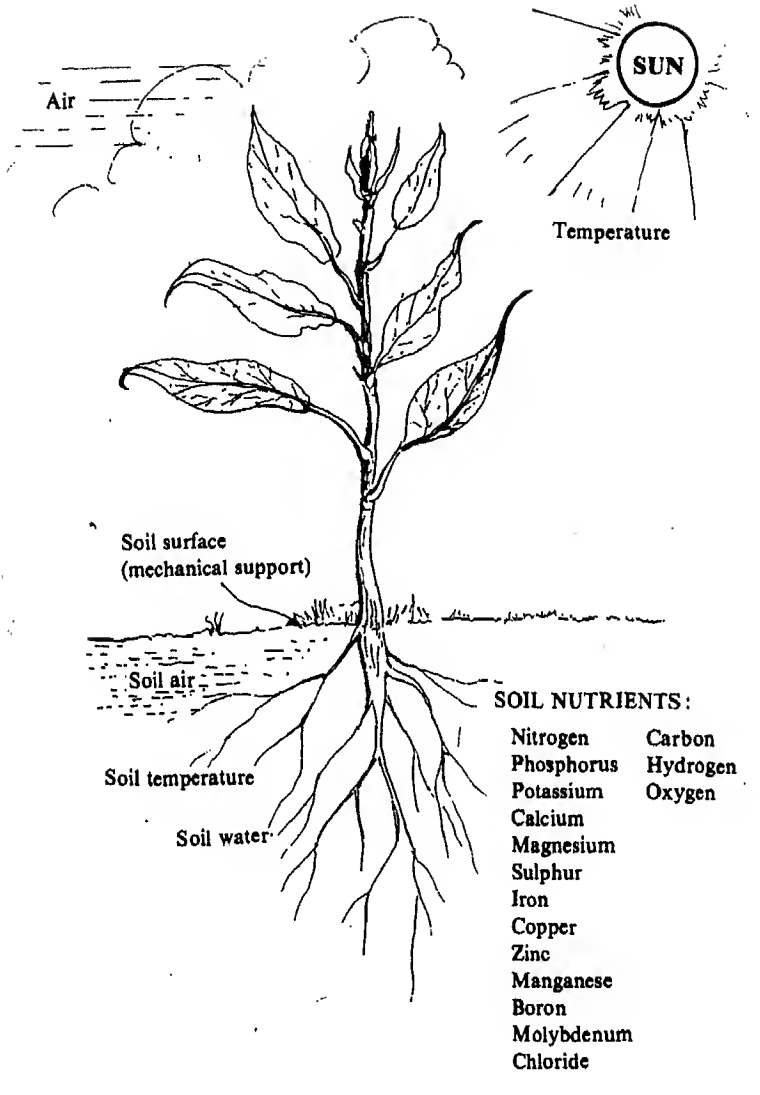

Fig. 1 FACTORS AFFECTING PLANT GROWTH

and water. Soil is the store-house for the supply of other nutrients. Each crop grown depletes soil of its nutrients by a certain amount. Hence management of soil either by replenishing nutrients by external sources or through proper crop management practices is necessary. This has become still more important these days as the needs of food, fodder, fibre, and other crops is increasing with mounting pressure of population. Under such circumstances, intensive cultivation is the only way out. This leads to more utilization of nutrients from the soil which has limited supply of most of these nutrients. The problem is more serious with N than with other nutrients. Additional requirement of nutrients (s) is supplied to the soil through fertilizers and manures.

With more and more availability of better seeds (High yielding varieties), irrigation facilities, plant protection measures and need for greater agricultural production, supply of manures alone cannot produce the desired yields. Use of chemical fertilizers is the key to achieve the high crop production. Among macro-nutrients, only three primary nutrients (N, P and K) are utilized by the crops in large quantities. Fertilizers are being manufactured throughout the world for the supply of these three nutrients. These fertilizers are available in straight, compound or complex and mixed forms. Nitrogen containing fertilizers are called nitrogenous fertilizers; similarly phosphorus and potassium containing fertilizers are called phosphatic and potassic fertilizers, respectively.

Considering the high cost of fertilizers, their efficient use demands utmost attention. Various methods of their application are based on soil conditions and plant growth. High prices of fertilizers also compel the consumers to be selective.

Manures are organic substances rich in plant nutrients. These also provide food to soil micro-organisms. Manures not only add most of the essential nutrients to the soil but also improve the physico-chemical properties of the soil. Agricultural wastes like crop residues and animal wastes form the base material of most of the organic manures. These organic materials are decomposed in different ways before they are added to the soil. The organic materials are utilised in different ways for manuring purposes. The organic manures can be classified as follows:

(a) Bulky organic manure:

These are organic manures, used in bulk or in large quantity,

such as FYM, compost, super compost.

(b) Green manure:

These are green vegetative plant parts which are ploughed in the soil as manures, such as sunhemp, cowpea.

(c) Concentrated organic manure:

These are organic materials containing relatively higher content of plant nutrient (s) such as oil cakes, blood meal and bone meal.

(d) Biofertilizers:

These are microbial cultures, which make available plant nutrients such as Azolla, Blue green algae, Rhizobium and Azotobacter cultures.

Practical knowledge of using fertilizers and manures will make the vocational pupils more sound and rational on this aspect of crop production.

1. Activity Unit

STUDY OF N.P.K. DEFICIENCY SYMPTOMS IN CROPS

1.1 Instructional objectives:

The pupil should be able to:
— induce NPK deficiency symptoms on crop plants;
— study NPK deficiency symptoms on crop plants;
— appreciate the loss caused by deficiency.

1.2 Relevant information:

1.2.1 NPK Deficiency Symptoms

NITROGEN :

— Nitrogen deficiency causes yellowing of the plants.
— Generally the deficiency symptoms are first seen on the lower leaves.
— Plant growth remains stunted.

PHOSPHORUS :

— Deficiency of the phosphorus leads to stunted growth with restricted foliage.
— The plants appear either almost normal green or bluish green.
— Tips of lower leaves start drying first and the drying advances towards the base.
— Older leaves are reddish brown or show purple tinge.

POTASH :

— Weak stems which generally lodge.
— Leaf tips become acorched and drying of tip advances to the margin of the leaves.
— Premature death of the leaves in presence of adequate nitrogenous and phosphatic fertilizers.

1.2.2 Why to study deficiency symptoms?

To identify the limiting plant nutrient and to differentiate them from pest and diseases damages so as to take corrective steps.

1.2.3 Why shqld we correct the deficiencies?

To improve the yields.

1.2.4 How to correct the deficiencies?

By applying various organic and inorganic fertilizers in appropriate quantities.

- Nitrogen is applied through organic manures and inorganic fertilizers (Urea, Ammonium sulphate, Ammonium chloride, Calcium ammonium nitrate and Ammonium sulphate nitrate).
- Phosphorus is applied in the form of Super phosphate, Triple super, rock phosphate and Diammonium phosphate and other complex fertilizers which contain phosphorus.
- Potash is applied as Potassium sulphate or Potassium chloride (muriate of potash) and also in the form of complex fertilizers.

1.2.5 How to apply plant nutrients?

The best results are obtained when the nutrients are applied to soil as per various methods discussed in the Activity Unit on methods of application. However, in acute cases some of these nutrients are applied also as foliar spray.

1.2.6 In what cases the standing crop can be retrieved by applying deficient plant nutrients?

The crop retrieves from nitrogen deficiency if nitrogen is supplied.

Phosphorus and potash deficiency is not immediately corrected by application.

1.2.7 What is Hoagland and Arnon solution and its composition?

Hoagland and Arnon solution is a nutrient solution used for growing plants in solution and sand cultures. The deficiency symptoms of a particular nutrient element can be induced by eliminating that nutrient in the composition of the Hoagland and

Arnon solution. The composition of the solution is as under:

i. 0.001 M KH_2PO_4
ii. 0.005 M KNO_3
iii. 0.006 M $Ca(NO_3)_2$
iv. 0.002 M $MgSO_4$

} Culture solution

v. One millilitre of 0.5% solution of ferric tartrate per litre of culture solution.
vi. 2.5 g H_3BO_3, 1.5 g $MnCl_2, 4H_2O$, 0.10 g $ZnCl_2$, 0.05g $CuCl_2 2H_2O$ and 0.05 g $NaMoO_3$ dissolved in one litre of distilled water. One millilitre of this solution is usually added to each litre of the culture solution.

The deficiency symptoms can very often be observed on plants growing in very light soils.

1.3 Precautions:

— Ensure proper washing of the media (sand) used for plant growth.
— Provide proper drainage in the plastic pots or cups suggested here.

1.4 Materials required:

i. Plastic cups or small pots
ii White sand
iii Chemicals for the preparation of Hoagland solution (pH of final Hoagland solution should be around 6-8)
iv. Seeds of crops (Maize, Jowar, Greengram, cowpea, etc.)
v. Distilled water.

1.5 Procedure:

— Weigh about 500 g of nutrient free sand in 32 plastic cups or pots.
— Sow six seeds of each crop in each of the eight pots.
— Add distilled water to keep the sand moist.
— Maintain 4 seedlings in each pot.
— Start applying Hoagland solution as per the scheme below.

Treatments-4

i. N—deficient Hoagland solution

ii. P—deficient Hoagland solution
iii. K—deficient Hoagland solution
iv. Complete Hoagland solution

Crops-4

i. Maize
ii. Jowar
iii. Green gram
iv. Cowpea

Replications—2

— Add same amount of N-deficient Hoagland solution in two pots of all the four crops. Similarly P-deficient, K-deficient and complete Hoagland solution in two pots of all the four crops separately should be added.
— Allow the plants to grow for 45 days with addition of proper nutrient solution.

1.6 Observations:

The pupil should study the plants and record the following observations:

Character-istics	*Crops*	*Treatments*			
		N-deficient solution	*P-deficient solution*	*K-deficient solution*	*Complete Hoagland solution*
Height of plants	Maize Jowar Greengram Cowpea				
Colour of plants	Maize Jowar Greengram Cowpea				
Colour of leaves, midribs	Maize Jowar Greengram Cowpea				

Weight of plants	Maize Jowar Greengram Cowpea

1.7 Expected behavioural outcomes:

The pupil will be able to:

Grade

— wash the sand free from plant nutrients;
— sow the seeds;
— prepare Hoagland solutions with desired compositions;
— raise plants successfully;
— identify nutrient deficiency symptoms for each of the nutrient distinctly.

The teacher should evaluate the pupil for the above abilities.

1.8 Questions:

i. Describe deficiency symptoms of NPK in maize plants.
ii. Describe Hoagland solution.
iii. Describe function of N, P and K in plant.

2. Activity Unit

IDENTIFICATION OF FERTILIZERS

2.1 Instructional objectives:

The pupil should be able to:
— identify the straight fertilizers;
— classify them into three broad types of fertilizers.

2.2 Relevant information:

2.2.1 What are fertilizers?

These are plant nutrient carriers in a concentrated form and are inorganic in origin.

2.2.2 Why fertilizers?

The organic manures, by and large, are bulky in nature and are not available in sufficient quantities, whereas fertilizers are easy to handle and supply nutrients in easily available form to the plants.

2.2.3 What are different types of fertilizers?

Fertilizers are classified as:
— Straight (contains single nutrient i.e. Nitrogen or Phosphorus or Potassium).
— Compound or Complex (contains 2 or 3 nutrients, mixed uniformly by chemical method).
— Mixed (contains 2 or 3 nutrients prepared by mechanically mixing of different fertilizers).

On the basis of the main plant nutrient, the fertilizers are also classified as:
— Nitrogenous
— Phosphatic
— Potassic

2.2.4 Forms in which nitrogenous fertilizers are available

(a) NITRATE : These are highly soluble in water and available to the plants immediately. Because of high solubility they are easily leached out. These are not suitable in sandy soils. (Example : Calcium nitrate with 15.5% N).

(b) AMMONICAL : Except paddy and Potato the ammonical form is not directly absorbed by crops. Ammonical form is converted to nitrate before absorbtion by crops. But ammonical nitrogen though highly soluble is not washed out easily as it is retained in the soil. Continuous use may result soils becoming acidic (Example: Ammonium sulphate 20.6% and Ammonium chloride 25% N).

(c) AMMONICAL & NITRATE : These are also easily soluble in water. The nitrate nitrogen is first available to the crop and later the ammonical form converts into nitrate form and is available to the plant. They do not affect the soil pH. (Example: Calcium ammonium nitrate 26% N).

(d) AMIDE : Urea containing 46% N is the most commonly and widely used fertilizer under this head. As soon as this fertilizer is applied nitrogen turns into ammonical form. Later it is converted into nitrate nitrogen which is taken up by the crops. Urea can be used for foliar spraying also (2-3% concentration) since the plants can directly absorb amide forms.

2.2.5 Forms in which phosphatic fertilizers are available

(a) MONOPHOSPHATE : They are soluble in water. Suitable for all types of soil. Plants absorb phosphorus in monophosphate form ($H_2PO_4^-$). Soils are capable of fixing large amount of applied phosphorus. In other words phosphorus does not move in soil. Hence it is applied as basal dressing, i.e. below the seed for its maximum utilisation by the plants (Example: Single super phosphate—16% P_2O_5 and Triple superphosphate —40-48% P_2O_5).

(b) DIPHOSPHATE : They are citric-acid soluble. Suitable for neutral to slightly acidic soils (Example: Dicalcium phosphate—30% P_2O_5 and Basic slag—15-20% P_2O_5).

(c) TRIPHOSPHATE : They are both water as well as citric acid insoluble. Suitable for acidic soils, specially for plantation crops (Example: Rock phosphate— 20-25% P_2O_5 and Bone meal—20-25% P_2O_5).

2.2.6 Forms in which potassic fertilizers are available

The Potassic fertilizers are available as Muriate of Potash (60% K_2O) and Potassium Sulphate (50% K_2O). Both are water soluble. Potassium can be fixed in the soil. Therefore, they are generally applied as basal dressing.

2.3 Precautions:

— Store the fertilizer sample used fur identification properly.
— Avoid use of moist samples.

2.4 Materials required:

i. All types of fertilizers
ii. Water
iii. Container
iv. Litmus paper (blue and red)

2.5 Procedure:

— Take out the fertilizer samples from the bags or bottles.
— Observe them carefully.

2.6 Observations:

The pupil should take and record the following observations in the table 2.6.1.

Table 2.6.1: Characteristics of Fertilizers

Name of Fertilizers	*Hygroscopicity*	*Colour*	*Particle size*	*Solubility in water*	*Reaction by litmus paper*
I.	Nitrogenous				
	(a)				
	(b)				
	(c)				
II.	Phosphatic				
	(a)				
	(b)				
	(c)				
III.	Potassic				
	(a)				
	(b)				
	(c)				

2.7 Expected behavioural outcomes:

The pupil will be able to:

Grade

— recall the various forms of different types of fertilizers;
— classify fertilizers;
— identify fertilizers.

The teacher should evaluate the pupil for the above abilities.

2.8 Questions:

i. Name three water soluble phosphatic fertilizers.

ii. Name two fertilizers which are hygroscopic in nature.

iii. Which of the following forms are easily leached out from the soils.
   (a) Ammonical
   (b) Nitrate
   (c) Diphosphate

iv. What is the difference between prilled as granular forms of.

v. What is urea super granule?

vi. What are fillers?

vii. What is the difference between complex and mixed fertilizers?

viii. What are nitrophosphates?

3. Activity Unit

CALCULATION OF UNIT VALUE OF PLANT NUTRIENTS OF FERTILIZERS

3.1 Instructional objectives:

The pupil should be able to:

— identify the cheapest source of nutrient from available fertilizers;

— suggest the farmer about the preparation of cheapest mixture of fertilizers from the available sources.

3.2 Relevant information:

3.2.1 What is a unit value?

Unit value is the price of one unit (e.g. 1.0 kg) of a nutrient in a fertilizer. The pupils should be aware of the importance of calculating price per of plant nutrient in various fertilizers for more economic use of the latter.

3.2.2 Why to calculate the unit value of plant nutrient of fertilizers?

The fertilizers and manures are valued on the basis of plant nutrients contained in them. Generally the fertilizer companies indicate on the bag the total nitrogen, phosphoric acid and potash content as percentage.

The cost of unit weight of plant nutrient through different sources of fertilizers is calculated to determine and recommend to the farmer the cheapest fertilizer mixture he can prepare for his crop.

3.3 Precaution :

— Use the unit value of the cheapest source of nutrient while calculating the unit value of the nutrient in a complex/ compound fertilizer.

3.4 Materials required:

— Retail cost of all straight, compound and mixed fertilizers produced by different companies.

3.5 Procedure:

— Acquaint with the cost of the fertilizers.
— Acquaint with the formula for calculating the unit value of nutrient.

3.6 Calculations :

The pupil should calculate the unit value of nutrient by using the following formula.

$$\text{Unit value of a nutrient} = \frac{\text{Cost of straight fertilizer of known weight}}{\text{Total quantity of nutrient present in the known weight of fertilizer}}$$

For example : Price of one tonne of urea - Rs. 2040
Total quantity of nitrogen present - 460 kg.

Therefore, (1 Kg of Nitrogen) cost of unit value = 2040/460= Rs.4.43

3.6 a Calculate the unit value of nutrient of all nitrogenous, phosphatic and potassic straight fertilizers

3.6 b Calculate the unit value of nutrients in compound or mixed fertilizers

If a fertilizer consists of more than one plant nutrient, the main constituent of fertilizer should be decided and the fertilizer should be classified accordingly (like nitrogenous or phosphatic or potassic). Then the cost of the nutrient in smaller amount should be calculated on the basis of cheapest commercially available straight fertilizer and deducted from the total cost. The remaining cost is used to determine the unit value of nutrient present in larger quantity.

For Example : DAP consists of 18 kg N and 46 kg P_2O_5 in 100 kg.
Approx. cost of 100 kg of DAP—Rs. 314/-
Cost of 18 kg of Nitrogen = 18 x 4.43 (Unit value of cheapest nitrogen from urea) = Rs. 79.74
∴ Cost of 46 kg of P_2O_5 = Total cost—Cost of nitrogen
= Rs. 314-79.74 = 234.26
Unit value = 234.26/46 = Rs. 5.09
Unit value of P_2O_5 in DAP = Rs. 5.09

Unit value of Nitrogen in DAP = Rs. 4.43 (Taking the value of cheapest nitrogen fertilizer)

From the above example it is clear that DAP is a cheaper source of phosphate compared to super phosphate.

3.7 Expected behavioural outcomes:

The pupil will be able to:

- calculate the cost of unit value of plant nutrient in fertilizers;
- find out the cheapest source of plant nutrients from among various fertilizers available in the market.

Grade

The teacher should evaluate the pupil for the above abilities.

3.8 Questions:

i. What is the necessity to calculate unit value?
ii. Which nutrient should be taken into account for calculating its unit value in a compound fertilizers?
iii. How do you classify a compound/complex fertilizer?
iv. Why are compound/complex fertilizers preferred over straight fertilizers?

4. Activity Unit

ESTIMATION OF FERTILIZER QUANTITIES BASED ON CROP REQUIREMENTS/SOIL TEST DATA

4.1 Instructional objectives:

The pupil should be able to:

— recall the quantity of the nutrients removed by the field crops;
— estimate quantities of fertilizers needed based on crop requirements/soil test data;
— select the most economical form of fertilizers;
— work out plan of fertilizer requirement for wheat crop.

4.2 Relevant information:

4.2.1 Average plant nutrients removed by field crops

Crop	*Yield*	*t/ha*	*Nutrients removed kg/ha*		
			N	*P*	*K*
Paddy	Grain	2.8			
	Straw	5.6			
	Total	8.4	82	23	123
Wheat	Grain	2.2			
(Tall)	Straw	4.4			
	Total	6.6	59	29	67
Wheat	Grain	5.0			
(Dwarf)	Straw	7.5			
	Total	12.5	120	64	220
Jowar	Grain	1.1			
(Tall)	Straw	4.4			
	Total	5.5	52	18	86
Maize	Grain	2.7			
(Tall)	Straw	9.0			
	Total	11.7	118	45	105
Tobacco leaves (Dried)		1.2	80	20	53
Potato tubers		17.5	95	30	130
Sugarcane		90.0	120	50	290

4.3 Precautions:

— Enquire about the fertilizers available and calculate their cost in terms of nutrients present in them.
— Select the most economical ones on the basis of above enquiry.
— Account for the nutrients added through some other sources like organic manures or green manuring.
— Split the quantity of fertilizers according to time of their application.

4.4 Materials required:

i. Information about the prevailing cost of the fertilizers.
ii. Fertilizer recommendations for various crops.

4.5 Procedure:

— Visit the neighbouring farms.
— Enquire about the crop which the farmer is willing to grow.
— Enquire about the soil testing i.e. whether he has sent the soil sample for analysis to a soil testing Laboratory or not.
— If yes, enquire about the fertilizer recommendations made. If no, suggest blanket recommendation.
— Enquire about the type of fertilizers available in the nearby markets.
— Select the fertilizers on the basis of cost of unit value.
— Enquire about green manuring or application of F.Y.M. or compost.
— Calculate the quantity of fertilizers selected after accounting for the nutrients supplied by F.Y.M. or compost or green manuring.
— Suggest method and time of fertilizer application.

4.5 a A hypothetical situation:

A farmer wants to grow a high yielding wheat variety on one hectare land with assured irrigation facilities. He dicided to have a green manure crop during *Kharif* but it failed. So, he was advised to apply 80:40:40 to his wheat crop. Work out the quantity of fertilizers required and schedule of the application.

4.5a.1 List of fertilizers available and their cost

The farmer has the following fertilizers to choose from: Urea (46% N), Ammonium sulphate (20.6% N), Calcium ammonium nitrate (25.0% N), Single superphosphate (16% P_2O_5), Rock phosphate (30% P_2O_5), Muriate of potash (60% K_2O).

Price for 50 kg bag :

Urea...Rs. 120.00
Amm. sulphate Rs. 90.00
Calcium amm. nitrate Rs. 90.00
Single super phosphate Rs. 48.00
Rock phosphate Rs. 25.00
Muriate of potash Rs. 65.00

4.5a.2 Solution

— Plant nutrients added by green manure are not accounted since the crop failed.
— Unit value of nitrogen through various fertilizers.

UREA :

46 kg of N costs = Rs. 240
1 kg of N costs = 240/46 = Rs. 5.22

AMMONIUM SULPHATE :

20.6 kg of N costs = Rs. 180
1 kg of N costs = 180/20.6 = Rs. 8.73

CALCIUM AMMONIUM NITRATE:

25 kg of N costs = Rs. 180
1 kg of N costs = 180/25 = Rs. 7.20

— Unit value of phosphorus (P_2O_5) through various fertilizers.

SUPERPHOSPHATE :

16 kg of P_2O_5 costs = Rs. 96
1 kg of P_2O_5 costs = 96/16 = Rs. 6.00

ROCKPHOSPHATE :

30 kg of P_2O_5 costs = Rs. 50
1 kg of P_2O_5 costs = 50/30 Rs. 1.66
— Unit value of Potassium (K_2O) from Muriate of potash (MOP)
60 kg of K_2O costs = Rs. 130
1 kg of K_2O costs = 130/60 = Rs. 2.17

4.6 Observations:

The pupil should select the fertilizers from the above on the basis of the cost of unit value and suitability of fertilizers.

— For nitrogen, urea is the cheapest fertilizer.

— For phosphorus, although rock phosphate is the cheapest source but it is suitable for acidic soils. Hence for the wheat crop the application of superphosphate is preferred.

— For potash, since muriate of potash is the only source, question of selection does not arise.

4.7 Calculations:

The pupil should calculate the cost and quantity of selected fertilizers so as to supply Nitrogen, 80 kgs, P_2O_5 40 kg , K_2O 40 kg.

(a) COST OF FERTILIZER :

1 kg of N from Urea costs = Rs. 5.22
Hence 80 kgs of N will cost = 5.22 × 80 = Rs. 417.60
1 kg of P_2O_5 from super phosphate costs = Rs. 6.00
Hence 40 kg of P_2O_5 will cost = 6 × 40 = Rs. 240.00
1 kg of K_2O from muriate of potash costs = Rs. 2.17
Hence 40 kg of K_2O will cost = 2.17 × 40 = Rs. 86.80
Total cost of fertilizers to be supplied
= 417.60 + 240.00 + 86.80 = Rs. 744.40

(b) QUANTITY OF FERTILIZER :

46 kg of nitrogen is supplied by = 100 kg of urea
∴ 80 kg of nitrogen will be supplied by = 100/46 x 80
= 173.90 kg of Urea

16 kg of phosphorus is supplied by=100 kg of super phosphate
∴ 40 kg of phosphorus will be supplied by = 100/16 x 40
= 250 kg of superphosphate

60 kg of potash is supplied by = 100 kg of MOP
∴ 40 kg of potash will be supplied by = 100/60 x 40
= 66.6 kg of MOP

(c) RECOMMENDATIONS :

— The farmer would require Rs. 744.40 for the purchase of fertilizers.

— The farmer should buy Urea (173.9 kg) superphosphate (250 kg) and muriate of potash (66.6 kg) for supplying 80-40-40 kgs of N,P,K, respectively.

— The farmer should apply total quantity of super-phosphate, muriate of potash and half the quantity of nitrogen at the time of sowing. Remaining half quantity of nitrogen should be applied as top dressing in splits of equal amounts at the time of first and second irrigation.

4.8 Expected behavioural outcomes:

The pupil will be able to:

recall about the nutrient requirements of the crops;

— estimate the quantities of fertilizers;

— select economical form of fertilizers;

— suggest time and method of application of fertilizers.

Grade

The teachers should evaluate the pupil for the above abilities.

4.9 Questions:

i. Calculate the quantities of the following fertilizers per hectare for raising a high yielding wheat variety which is expected to yield 50 quintals per hectare. The crop requires 25 : 10 : 10 kg N, P_2O_5 and K_2O per tonne of the yield. Fertilizers available are:
(a) Urea, (b) Single superphosphate, (c) Muriate of potash.

ii. A farmer wants to grow potato crop in one hectare land with assured irrigation. He has already applied castor cake at 20 quintals per hectare in powder form a weak earlier to sowing. The cake contains 4.3% N, 1.8% P_2O_5 and 1.3% K_2O. Potato variety *Kufri Chamatkar* can produce 250 quintals per hectare yield with proper manuring. The crop requires 150 : 80 : 80 kg N, P_2O_5 and K_2O. Calculate the quantities of the following fertilizer and prepare manurial schedule:
(a) D.A.P., (b) Potassium sulphate, (c) Ammonium sulphate.

iii. What happens to the nutrient status of the soils if land is cultivated without fertilizer application for long time?

iv. Which of the following fertilizers is cheapest per unit of nutrient—
(a) Ammonium sulphate (20.6%N), Price Rs. 90/- per 50 kg.
(b) Super Phosphate (16.0% P_2O_5), Price Rs. 48/- per 50 kg.
(c) Urea (46.0% N), Price Rs. 120/- per 50 kg.

5. Activity Unit

PREPARATION OF FERTILIZER MIXTURES

5.1 Instructional objectives:

The pupil should be able to:
— recall the compatibility of fertilizers;
— identify fertilizers;
— formulate and prepare the fertilizer mixtures.

5.2 Relevant information:

5.2.1 What is a fertilizer grade?

It refers to the percentage of plant nutrient in terms of total nitrogen, available P_2O_5 and K_2O in a fertilizer. A fertilizer with 20-20-10 grade indicates that 100 kg contains 20 kg N, 20 kg P_2O_5 and 10 kg K_2O.

5.2.2 What is the fertilizer ratio?

It refers to the ratio of nitrogen to P_2O_5 and to K_2O. A fertilizer with 20-20-10 grade has 2 : 2 : 1 ratio of N : P_2O_5 : K_2O.

5.2.3 What is the fertilizer formula?

It is an expression of the quantity and forms of nutrients in a fertilizer.

5.2.4 What is a filler?

A filler is a make-weight material added to a mixed fertilizer or fertilizer material to make the difference between the weight of the added ingredients required to supply the plant nutrients in a tonne.

5.2.5 What types of fillers are used?

Inert material such as sand, lime stone, gypsum and dolomite are

generally used as fillers.

5.2.6 Compatibility of fertilizers

All straight fertilizers can not be used for mixing as some of them are incompatible with others. Fig. 5.2.6. shows which straight fertilizers can be mixed and stored and those which can be mixed just before application and those which should not be mixed.

CALCIUM AMMONIUM NITRATE	AMMONIUM SULPHATE NITRATE	AMMONIUM SULPHATE	UREA	DIAMMONIUM PHOSPHATE	SUPER PHOSPHATE	TRIPLE SUPER PHOSPHATE	BASIC SLAG	ROCK PHOSPHATE	MURIATE OF POTASH	POTASSIUM SULPHATE	
+	*	*	×	*	×	×	×	×	+	*	CALCIUM AMMONIUM NITRATE
*	+	+	×	+	*	*	×	×	*	+	AMMONIUM SULPHATE NITRATE
*	+	+	*	+	+	+	×	×	+	+	AMMONIUM SULPHATE
×	×	*	+	*	×	×	*	*	*	+	UREA
+	+	+	*	+	+	+	×	×	+	+	DIAMMONIUM PHOSPHATE
×	*	+	×	+	+	+	×	×	+	+	SUPER PHOSPHATE
×	*	+	×	+	+	+	×	×	+	+	TRIPLE SUPER PHOSPHATE
×	×	×	*	×	×	×	+	+	+	+	BASIC SLAG
×	×	×	*	×	×	×	+	+	*	*	ROCK PHOSPHATE
+	*	+	*	+	+	+	+	*	+	+	MURIATE OF POTASH
*	+	+	+	+	+	+	+	*	+	+	POTASSIUM SULPHATE

\+ Fertilizers which can be mixed and stored
* Fertilizers which can be mixed but not stored longer than 2-3 days
× Fertilizers which cannot be mixed

Fig. 5.2.6 DIAGRAM SHOWING COMPATIBILITY OF FERTILIZERS

5.2.7 Preparation of mixtures

Mixture are convenient to prepare. For this purpose the following examples are given to show how the calculations are made

to arrive at basic ingredients required for preparing a mixture.

Example—1

Prepare a mixture using urea, superphosphate and muriate of potash to supply 50 kg N, 50 kg P_2O_5 and 50 kg K_2O.

Urea contains—46% N

∴ 50 kg N is present in = 100/46 x 50 = 108.7 kg urea

Superphosphate contains—16% P_2O_5

∴50 kg P_2O_5 is present in = 100 x 50/16
= 312.5 kg Superphosphate.

Muriate of potash contains—60% K_2O

∴ 50 kg K_2O is present in = 100 x 50/60 = 83.3 kg muriate of potash.

Fertilizers required

Urea—110 kg (approx.)
Superphosphate—310 kg (approx.)
Muriate of potash—85 kg (approx.)

Example-2

Prepare 100 kg mixture of grade 4-8-12 for groundnut using ammonium sulphate, super-phosphate, and muriate of potash using gypsum as a filler.

Ammonium sulphate contains—20% N

∴ 4 Kg N is present in = 100 × 4/20 = 20 kg Amm. sulphate

Super phosphate contains —16% P_2O_5

∴ 8 kg P_2O_5 is present in = 100 × 8/16 = 50 kg superphosphate

Muriate of potash contains—60% K_2O

∴ 12 Kg K_2O is present in = 100 × 12/60 = 20 kg muriate of potash

Fertilizers required

Ammonium sulphate—20 kg
Super phosphate—50 kg
Muriate of potash—20 kg
Total : 90 kg
Filler (gypsum)—10 kg
Total : 100 kg

Example-3

Prepare a mixture with Di. Ammophos, calcium ammonium

nitrate and potassium sulphate to supply 40 kg N, 60 kg P_2O_5 and 60 kg K_2O.

Di-ammophos (DAP) contains 18% N and 46% P_2O_5

$\therefore$ 60 kg P_2O_5 is present in = 100 × 60/46 = 130 kg Di-ammophos.

130 kg DAP contains 18 x 130/100 = 23.4 kg N

130 kg DAP contains 60 kg P_2O_5 and 23.4 kg N

Remaining N (16.6 kg) is supplemented by CAN

Calcium Ammonium Nitrate (CAN) contains—25% N

$\therefore$16.6 kg N is present in = 100 × 16.6/25 = 66.4 kg CAN.

Potassium sulphate contains (SOP)—50% K_2O

$\therefore$60 kg K_2O is present in = 100×60/50 = 120 kg potassium sulphate.

Fertilizer required		*Nutrients supplied*		
		N	P_2O_5	K_2O
DAP	—130 kg	23.4	60	—
CAN	—66.4 kg	16.6	—	—
SOP	—120 kg	—	—	60
		40	60	60

5.3 Precautions:

— Take sufficient care about hygro-scopicity of Urea and CAN.
— Store mixtures carefully in polythene bags to protect them from absorbing moisture.
— Check the weights of bags of mixtures purchased from local manufacturers.

5.4 Materials required:

i. Weighing balance
ii. Spade or Shovel
iii. Tarpaulin
iv. Gunny bags
v. Fertilizers
vi. Filler

5.5 Procedure :

— Find out the various types of fertilizers available in the market.
— Calculate the unit cost value for each fertilizer.

— Select the fertilizers which are compatible and cheaper as per unit cost value.
— Weigh the fertilizers as per the ratio of total quantity of fertilizer mixture required.
— In case filler is required to make up the quantity of fertilizer mixture, it should also be weighed.
— Spread the largest quantity fertilizer on the pucca floor in a thin layer.
— Spread other fertilizers over this layer.
— Spread the filler, if any.
— Take the spade and mix the fertilizers.
— Repeat mixing of the material 2 to 3 times.
— Take the sample from the heap of fertilizer material and check to ascertain the composition in respect of NPK.
— Fill the mixture in polythene coated gunny bags.
— Mixture is ready for application.
— Calculate the cost of mixture.

5.6 Observations:

The pupil should take the following observations:

a. Whether the mixture is homogenous?
b. Whether the mixture has the desired composition?
c. Whether the mixture has absorbed any moisture during the process of mixing?

5.7 Expected behavioural outcomes:

The pupil will be able to:

— explain the details given on the fertilizer bag;
— select fertilizers on the basis of compatibility;
— select fertilizers on the basis of cost per unit value;
— weigh and mix the fertilizers.

Grade

The teacher should evaluate the pupil for the above abilities.

5.8 Questions :

i. What do you understand by the legend 15-5-5 written on a bag of fertilizer?
ii. What precautions should be taken while making a mixed fertilizer?

iii. Estimate the quantity of ammonium sulphate, super phosphate and muriate of potash required to make 50 kg of a 6-6-6 mixture for basal dressing
iv. Calculate the quantity of urea, super phosphate, muriate of potash and gypsum required to make 100 kg of 16-4-4 grade mixture
v. Find out the quantity of Diammonium phosphate (18:46), Ammonium sulphate and Muriate of potash to make 100 kg of a mixture containing NPK in the grade of 12-24-12.
vi. What is compatibility in fertilizer mixing?
vii. What are "fillers" and why are they used in fertilizer mixtures?

6. Activity Unit

METHODS OF FERTILIZER APPLICATION

6.1 Instructional objectives:

The pupil should be able to:

- —recall the important properties of fertilizers that are commonly used;
- —recall the correct stage of crop growth for application of fertilizers;
- —practice various methods of fertilizer application.

6.2 Relevant information:

6.2.1 When to apply ?

Most of the crop plants generally require nitrogen throughout their growth period. Irrespective of the crop, all plants tend to grow at a slow rate in the beginning, rapidly in the grand growth period and again slowly during maturity, accordingly the nitrogen is also taken up by the plants. Nitrogenous fertilizers are soluble in water hence liable to be leached. As such it is necessary to apply nitrogenous fertilizers in split doses of 2 to 4 depending on the type of soil and the duration of crop. When the fertilizer is applied at sowing, it is called basal dressing and the dose of the fertilizer applied after basal dressing in standing crop is called top dressing.

Plant utilizes about two thirds of its total phosphorus requirementwhen it accumulates one third of its dry weight. Secondly phosphatic fertilizers release phosphorus very slowly which may also get fixed with clay mineral present in the soil. The monocalcium phosphate (water soluble) is transformed to di-and tri-calcium phosphate (insoluble fraction) reducing the availability of phosphorus to the plants. Hence the full dose of phosphatic fertilizers is always applied in the basal dressing itself.

Intake of potash by plant is similar to that of nitrogen. But its availability to plant is limited like that of phosphorus. Soils rich in

clay fix the applied potassium and release it very slowly. As such it is advisable to apply the entire quantity of potassic fertilizer at sowing time.

6.2.2 How to apply ?

As per crop requirement and growth pattern, plant nutrients are applied by adopting different methods which are discussed below:

(a) BROADCASTING :

The fertilizer is broadcast all over the field with a view to distribute the whole quantity of fertilizer uniformly.

(i) At the time of planting :

Depending on the crop, broadcasting of fertilizer is carried out prior to sowing/planting just before the last ploughing and incorporated in the field.

(ii) During crop growth period :

Broadcasting in standing crop (top dressing) is done mainly for nitrogenous fertilizers and mostly for closely spaced crop like paddy and wheat. Muriate of potash is also applied as top dressing in some crops but this is not a general practice.

(b) PLACEMENT :

Fertilizers are placed in the soil before sowing and relative to the position of the seed. Placement of fertilizer restricts the surface area of the fertilizer coming in contact with soil particles and thus decreases the fixation of phosphorus and potassium

(i) Plough furrow or single band placement :

Fertilizer is placed in a continuous band at the bottom of the furrow opened during ploughing. Each band is covered with soil after the application. In single band placement, fertilizer is applied on one side of the planted row (Fig. 6.2.2.1).

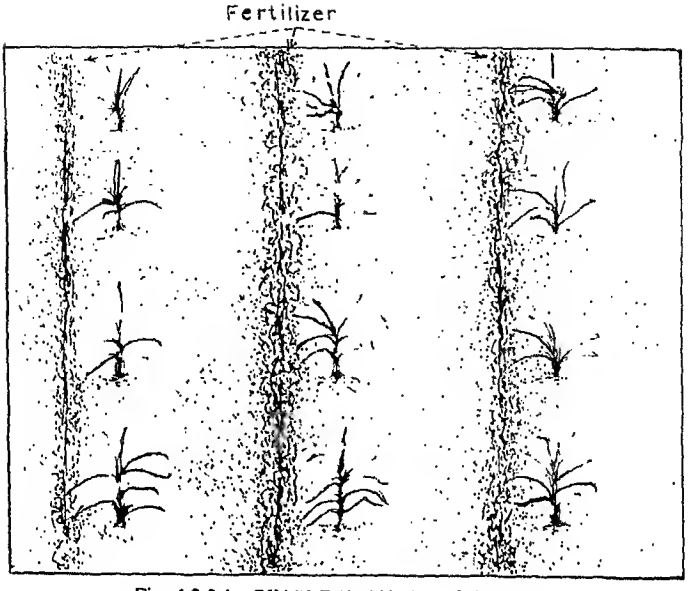

Fig. 6.2.2.1 SINGLE BAND PLACEMENT

(ii) Double band placement :

When the fertilizer is applied in two bands i.e on both the side of planted rows, it is called double band placement (Fig. 6.2.2.2).

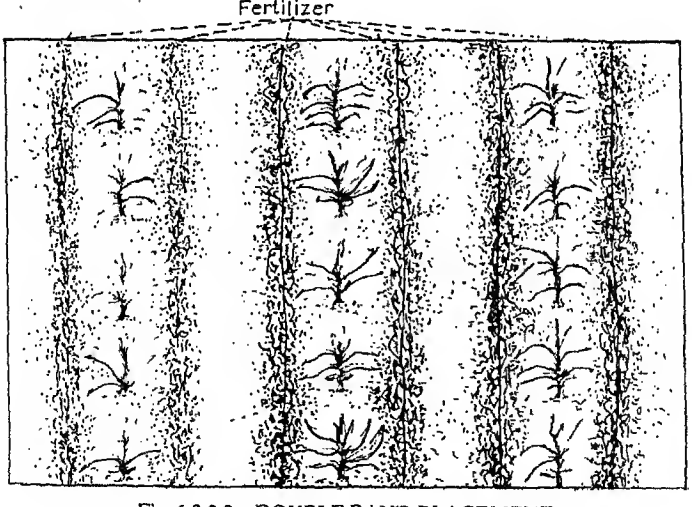

Fig. 6.2.2.2 DOUBLE BAND PLACEMENT

Placement of fertilizers is generally employed for the application of nitrogenous, phosphatic and potassic fertilizers in intensive agriculture and in orchards.

Deep placement of fertilizer is generally practiced for application of nitrogenous and phosphatic fertilizers in paddy fields. By this method ammonium or ammonia forming fertilizer is placed in the reduction zone, where it becomes available as ammonium ion to the crop plant during active vegetative period of growth. Deep placement of fertilizers is commonly recommended in the dry land agriculture.

(iii) Ring placement :

The quantity of fertilizer per plant is calculated and applied at some depth around the plant in a circle (Fig. 6.2.2.3). This method is mostly practiced in orchard crop.

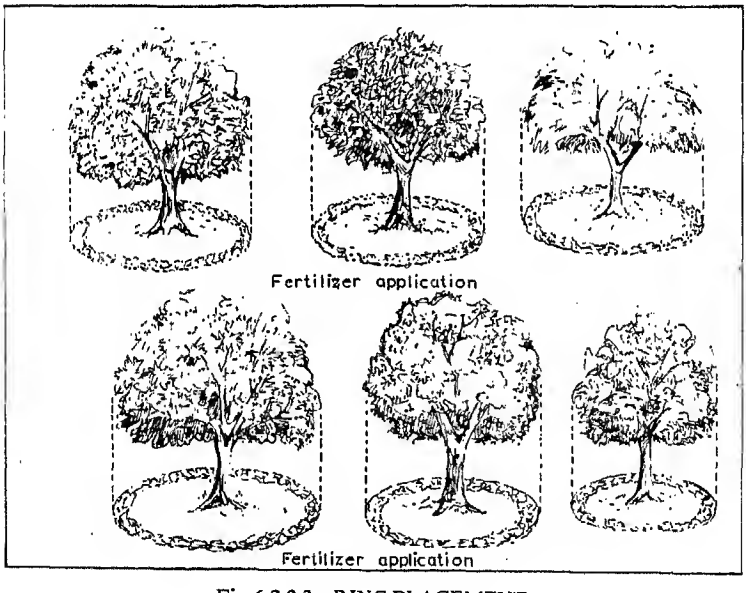

Fig. 6.2.2.3 RING PLACEMENT

(c) IN-SITU APPLICATION :

(i) Drill application :

Drill placement refers to the drilling of fertilizer at sowing time. Drilling the fertilizer together with seed should be

avoided as it may adversely affect the germination or the young plants may get damaged due to increased salt concentration in the root zone. It is advisable to use a separate attachment for seed and fertilizer drilling (Fig. 6.2.2.4). This is one of the best method for applying phosphatic and potassic fertilizer to closely spaced row planted crops like Wheat, Maize, Jowar, Bajra, etc. This method is considered superior for even nitrogenous fertilizer as compared to broadcasting.

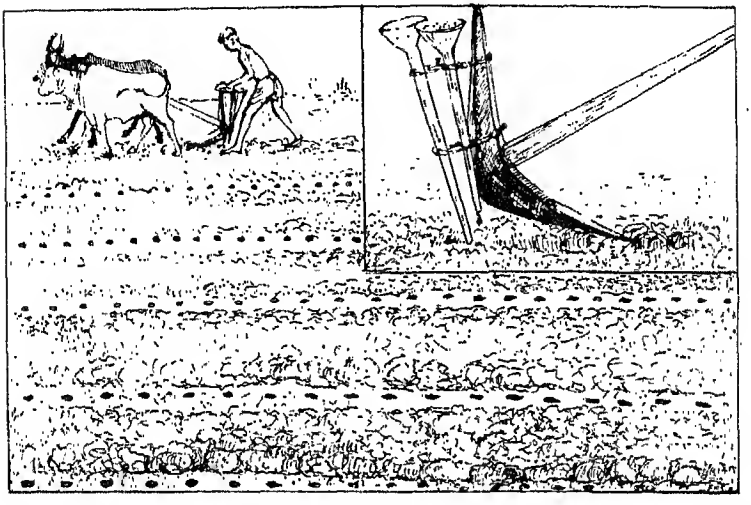

Fig. 6.2.2.4 DRILL APPLICATION

(ii) Dollop Method :

The entire quantity of fertilizer is calculated per plant and is applied on both the sides of the plant with the help of a cup by dividing it into two parts. This is considered to be very efficient method of applying nitrogenous fertilizer in widely spaced crop like american cotton.

(d) FOLIAR APPLICATION :.

Foliar application refers to the spraying of solution on foliage (leaves) of growing plants (Fig. 6.2.2.5). In general these solutions are prepared in low concentration (2-3%) usually to supply only one (occasionally more than one) plant nutrient.

Fig. 6.2.2.5 FOLIAR APPLICATION

6.2.3 Why foliar spray ?

i. Foliar spraying is useful to correct the nutrient deficiency in growing crops.
ii. In extreme dry weather condition where the plant cannot take up the nutrients from soil because of low moisture content foliar spray is useful.
iii. When quick response fertilizers is required.
iv. The growth of the crop prevents application of fertilizer to the soil but permits foliar application through a high clearance sprayer or from a helicoptor.

6.2.4 Draw backs in foliar spray

i. Marginal leaf burn or scorching may occur if strong solutions are used.
ii. As a solution of low concentration only a small quantity of nutrients can be supplied at a time.
iii. Several applications are needed and thus increasing the spray cost until and unless combined with other spraying operation.
iv. Cannot be recommended as sole method of application of fertilizer.

The following fertilizers can be used for the foliar spray.

i. Urea
ii. Micro-nutrients

6.3 Precautions:

6.3 a Soil application

— Note that there is a sufficient moisture in the field before applying fertilizers.
— Make uniform distribution of fertilizer on the entire area of operation.
— Avoid hot hours while broadcasting a fertilizer.
— Choose a fair weather day preferably for broadcasting.
— Don't top-dress the fertilizer when the crop leaves are wet, otherwise burning or scorching of leaves may occur.
— Confirm the compatibility of fertilizers before mixing them.
— Place the fertilizer at least 5 to 8 cm below the soil surface.
— Cover the fertilized row (furrow) with soil immediately.
— In double band placement, open the bands by keeping the planted row in centre.
— In ring placement, open the ring near the active root zone of fruit plants.
— Avoid drilling of fertilizers and seed together specially of pulses and legumes as even a small amount of fertilizer may damage germination.
— Check chocking of the tube from time to time.
— In dollop method, do not dibble the fertilizer either too far or too near to the plants.

6.3 b Foliar application

— Select only spray grade urea for foliar spray.
— Prepare fresh solution for each spray.
— Avoid spray during hotter period of the day. Spraying during afternoon is preferable.
— Avoid cloudy, rainy, and windy days for spraying.
— Repeat the spray if rains interrupt or wash out the spray on leaves.

6.4 Materials required:

i. Plough
ii. A pair of bullock
iii. Seed tubes
iv. Two tyned harrow
v. Spade
vi. Fertilizer cup

vii. Sprayer
viii. Bucket
ix. Plastic basin
x. Tape
xi. Weighing balance (single pan)
xii. Fertilizers
xiii. Water
xiv. Soap solution or teepol
xv. Stick
xvi. Lime powder

6.5 Procedure:

6.5 a Broadcasting

— Measure the field.
— Divide the field in convenient units.
— Calculate and weigh the fertilizer for each unit.
— Spread the fertilizer uniformly on the entire surface of each unit.

6.5 b Placement

(i) SINGLE BAND OR PLOUGH FURROW :

— Open the furrow with the help of plough.
— Count the number of furrows opend in the area of operation.
— Measure the length of furrow.
— Calculate and weigh the required fertilizer for each furrow.
— Apply the fertilizer uniformly in the furrow.
— Cover the furrow with the soil.

(ii) DOUBLE BAND :

— Open two furrows with the help of two tyned harrow keeping the planted row in the centre.
— Count the number of rows and measure the total area of operation.
— Calculate and weigh the required fertilizer for each row.
— Apply the fertilizer uniformly in the furrow.
— Cover the furrow with the soil.

(iii) RING PLACEMENT :

— Open a ring around the fruit tree with the help of spade.
— Calculate and weigh the fertilizer for each plant separately.

— Apply the fertilizer uniformly in the ring.
— Cover the ring with soil.
— Apply irrigation, if required.

6.5 c In-Situ application

(i) DRILLING :

— Attach the fertilizer drilling tube to the plough.
— Measure the area of operation.
— Calculate and weigh the required fertilizers.
— Drill the fertilizer taking care of the uniform distribution in the field.

(ii) DOLLOP METHOD :

— Count the number of plants in the area of operation.
— Calculate and weigh the required fertilizer.
— Put a mark in the fertilizer cup for the desired quantity of fertilizer for each plant.
— Dig a hole on both the side of the plants with the help of spade/appropriate tool to a 10 cm depth.
— Apply the fertilizer equally in both the holes and cover it with soil.

6.5 d Foliar Spray

(i) UREA SPRAY :

— Measure the area of operation.
— Calculate and weigh the required amount of urea.
— Dissolve the urea in required amount of water (500-800 q/ha).
— Add teepol or bathing soap just to make the solution suitable for spraying.
— Spray the solution till plants are sufficiently drenched.

(ii) MICRONUTRIENT SPRAY :.

— Measure the area of operation.
— Calculate and weigh the required chemical.
— Dissolve the chemical in required amount of water.
— Add lime to neutralize the acidity if prevails.
— Spray the solution uniformly on the crop with the help of sprayer taking care that plants are sufficiently drenched.

6.6 Observations:

The pupil should take the following observations :

— Check the tube attachment with plough for the proper depth?
— Whether the fertilizer has been distributed uniformly?
— Whether the fertilizer has been applied at proper depth?
— Whether the furrows are opened at equal distance?
— Whether the furrows are opened in straight line?
— The ingredients of the foliar spray have been dissolved properly.
— Check the tube attachment with plough for the proper depth?

Beside, the pupil should also observe the changes in the crop after 3 to 5 days after fertilizer application.

Characteristics	*Method of fertilizer application*		
	A	*B*	*C*
a. Colour of the crop			
b. Vegetative growth			
c. General appearance			

6.7 Expected behavioural outcomes:

The pupil will be able to:

— explain the properties of various fertilizers;
— recall the correct stage of plant growth for fertilizer application;
— practice all the methods of fertilizer application.

Grade

The teacher should evaluate the pupil for the above abilities.

6.8 Questions:

i. The quantity of nitrogenous fertilizer required for a particular crop should be applied in two or more splits, explain, why ?

ii. It is advisable to apply entire quantity of phosphatic fertilizer at the time of sowing, explain, why ?
iii. What do you mean by in-situ application ?
iv. Under what circumstances one should go for foliar spray of nutrients.
v. What precautions should be observed while doing the foliar spray of nutrient ?
vi. Which method should be used for applying urea to widely spaced cotton ?
vii. Which method should be used for applying nitrogenous fertilizer in standing crop of wheat.
viii. Which is the best method for fertilizer application in fruit orchard.

7. Activity Unit

MICRO-NUTRIENT APPLICATION

7.1 Instructional objectives:

The pupil should be able to:

- recall the micro-nutrients required for plant growth;
- recall the deficiency symptoms of the micro-nutrients in plants;
- recall the soil conditions which lead to micronutrient deficiency;
- apply micro-nutrients.

7.2 Relevant information:

7.2.1 What are micro-nutrients?

Out of 16 essential plant nutrients iron, manganese, boron, zinc, copper, molybdenum and chlorine are seven elements which are required for plant growth in small quantities and are known as micro nutrients.

7.2.2 Why micro-nutrients should be applied?

Though required in small quantities the absence of these nutrients affects the absorbtion of other elements resulting in poor crop growth.

7.2.3 Deficiency symptoms of micronutrients

Though it is difficult to identify and pin point the deficiency the following are the general symptoms:

IRON :

Young leaves show chlorosis. Principal veins are green-stalks are short and slender. Also death of growing tissues and rosetting can be observed commonly.

MANGANESE :

Chlorosis is the common symptom. Which is either called yellow disease or streak disease. It generally occurs between the veins and first occurs in young leaves. The yellow spots gradually become white.

BORON :

Terminal leaves become light green at base and break down. In onion the growth is stunted, leaves become dark gray. Lesions in pith in cauliflower are seen. In ground nut crop growth is affected and leaf tips become yellow.

COPPER :

Young leaves wilt and remain rolled, green leaves show chlorosis. In legumes the growth is stunted, leaves wither and extensive shedding occurs. In tomato, copper dificiency is well marked.

ZINC :

Maize plants 15 days after germination become white in colour. In paddy bronzing of middle leaves take place which is called as *Kaira* disease. In wheat white spots appear on middle leaves between veins which spread and coalesce. In older leaves chlorophyll development does not take place. In lemon, yellow striping of leaves between veins is observed. Older leaves die, plants get stunted and fruits are small. Little leaf or rosetting is common.

MOLYBDENUM

In tomato leaf edges curve. Lower leaves become brittle and surface becomes uneven (not common).

CHLORINE :

The deficiency symptoms are generally not observed.

7.2.4 What are the soil conditions which lead to micronutrient deficiency ?

— Highly acidic leached and other sandy soils.
— Soils with poor drainage and high water table.
— Soil with very low organic content and also in peat and muck soils.

— Calcarious saline and alkali soils with high pH.
— Soils which have been intensively cropped and where commercial fertilizers were in use for long time without the use of organic manures.
— Soils with high lime content.

7.2.5 How micronutrient deficiency can be corrected ?

i. Soil application :
The required quantity of material is finely ground and applied to soil.

ii. Foliar application :

Spraying of micro-nutrients in the form of a solution is taken up when the crops show deficiency symptoms (refer table given below for preparing individual micro-nutrient solution).

7.2.6 What are commonly available micro-nutrient carriers and their rate for application in soil or foliar spray?

Table below gives ranges of micronutrients that can be applied to crops

	Micronutrient	*Compounds commonly used*	*Safe ranges for soil application kg/ha*	*% age of concentration for foliar spray*
i.	Iron	Ferrous sulphate	25.0 to 50.0	0.2 to 0.5
ii.	Manganese	Manganese sulphate	25.0 to 50.0	0.2 to 0.5
iii.	Zinc	Zinc sulphate	25.0 to 50.0	0.2 to 0.5
iv.	Boron	Sodium Borate (Borex)	15.0 to 50.0	—
v.	Molybdenum	Sodium or Ammonium Molybdate	0.1 to 1.0	0.02
vi.	Copper	Copper Sulphate	10—20	0.2 to 0.5

Normally chlorine dificiency is not found as the loss is replenished in nature. Application of sufficient quantities of organic manures, green manures and oil cake once in 2 or 3 years makes the soil rich in micronutrients.

7.3 Precautions :

— Identify correctly whether it is a deficiency symptom or not.
— Prefer to apply the nutrient to soil if time permits.
— Study the other crops in the area for confirming the deficiency.
— In foliar application, prepare the solution of appropriate concentration.
— In order to avoid scorching due to foliar spray, take stock of the prevailing weather conditions.
— Test the spray solution for acidity and add lime to neutralize it if required.

7.4 Materials required :

i. Plough or seed drill or spade
ii. Sprayer
iii. Container
iv. Micronutrient carriers
v. Water
vi. Lime
vii. pH meter or pH strips
viii. Price list for available fertilizer
ix. Physical balance
x. Measuring tape

7.5 Procedure :

(a) *Soil application*

— Open furrow with plough or seed drill or spade.
— Apply calculated quantity of fertilizer on the basis of furrows per unit area.
— Cover the furrow with soil.
— Keep a control plot of same size for observing the differences.
— In a standing crop, apply micronutrients about 5 to 10 cm away from the plant depending on the crop by opening a hole with a spade and then cover it up.
— Keep a control plot of same size for observing the difference.

(b) *Foliar application*

— Prepare a solution of micronutrient taking care to attain the recommended concentration.

— Check the pH of the solution and add lime if it is acidic to make it neutral.
— Spray the solution, preferably in the evening on the foliage of the crop.
— Keep a control plot of same size for observing the difference.

7.6 Observations :

The pupil should take and record the following observations :

	Treatment	*Growth pattern*	*Yield kg/ha*
i.	*Control plot*		
ii.	*Sprayed plot*		
iii.	*Soil applied plot*		

7.7 Expected behavioural outcomes :

The pupil will be able to :

— identify micronutrient deficiency symptoms;
— apply micronutrients;
— explain the soil conditions which lead to micronutrient deficiency.

Grade

The teacher should evaluate the pupil for the above abilities.

7.8 Questions :

i. What are micronutrients?
ii. Why micronutrients are applied?
iii. Why pH of spray solution should be checked?
iv. What happens if the concentration of spray solution is high?

8. Activity Unit

EFFICIENT USE OF NITROGENOUS FERTILIZERS

8.1 Instructional objectives :

The pupil should be able to :

— explain the importance of efficient use of nitrogenous fertilizers;

— recall the methods for efficient use of nitrogenous fertilizers.

8.2 Relevant information :

8.2.1. Why efficient use of nitrogenous fertilizers?

With continuous increase in the cost of fertilizers and relatively low recovery of applied fertilizer nitrogen various steps have to be taken for increasing fertilizer use efficiency.

Applied nitrogenous fertilizers may undergo leaching and or volatilization resulting in heavy losses of nitrogen. The average recovery of applied nitrogen by plants is only about 30 to 50 per cent. 'Neem-cake' or Sulphur coated urea results in slow release of nitrogen as well as inhibiting nitrification of ammonical nitrogen thus improving uptake of the nutrient by the plants.

8.2.2 Methods for efficient use of nitrogenous fertilizers

There are three popular and practical methods of fertilizer application which ensure efficient use of nitrogenous fertilizers.

(a) USE OF COATED FERTILIZERS :

In this, nitrogenous fertilizer, specially urea is coated with neem-cake or sulphur powder. Coating reduces release of nitrogen from fertilizer granules, hence increases its availability.

(b) USE OF SUPER GRANULES OF UREA :

Urea in the forms of super granules (About 1.0 g) is now a days

available in the market. When it is applied in the fields, it dissolves slowly and makes the nitrogen available to plants for longer time thereby reducing the losses through leaching as well as volatilization.

(c) APPLYING OF UREA WITH BULKY ORGANIC MANURES :

After opening the furrows, well decomposed compost or farm yard manure is applied @ 5 to 10 times the weight of urea application depending on the availability of organic manure. After the manure is applied, urea is placed on it so that in case of heavy rain or irrigation the leaching losses are minimised.

8a. Sub Unit : **Coating of Nitrogenous Fertilizer (Urea)**

8a.1 Instructional objectives :

The pupil should be able to :

— prepare the Coaltar solution of uniform consistency by using kerosene;
— treat the fertilizer granules with coaltar solution;
— mix the treated fertilizer granules with 'neem cake'.

8a.2 Precautions :

— Coat the fertilizer in seed dressing drums or on a pucca floor.
— Prepare the Coaltar solution of a uniform consistency.
— Take finely powdered 'Neem cake' to get better coating.
— Take care to mix 'neem-cake' powder uniformly.

8a.3 Materials required :

i. Seed dressing drum
ii. Four litre capacity open tin
iii. Urea
iv. Kerosene
v. Coaltar
vi. Fine powder of 'Neem cake' or Sulphur.

8a.4 Procedure :

— Take 2.0 litres kerosene and thoroughly mix it in 1.0 kg Coaltar.

— Put 100 kg Urea in Seed dressing drum or on a pucca floor.
— Pour the coaltar solution evenly on Urea in the drum or on the heap of Urea on the floor.
— Mix 20 – 30 kg 'Neem Cake powder' thoroughly to result into thin coating of urea granules with Coaltar solution and powder. Coaltar solution acts as a sticker.

8a.5 Observations :

The pupil should take the following observations :

i. Uniform coating of the urea granules.
ii. Free flowing condition of urea granules.

8a.6 Expected behavioural outcomes :

The pupil will be able to :

Grade

— explain the importance of efficient use of nitrogenous fertilizers.
— undertake coating of urea.

The teacher should evaluate the pupil for the above abilities.

8a.7 Questions :

i. How is nitrogen lost from the soil following application of nitrogenous fertilizers?
ii. Why is urea coated with the 'neem-cake' or sulphur powder?
iii. Why 'neem cake' should be finely powdered?
iv. Can you use some oil cakes other than 'neem-cake' for coating the urea?

8b. Sub Unit : A Study of Methods for Efficient Use of Nitrogenous Fertilizers

8b.1 Instructional objectives :

The pupil should be able to :
— practice the methods for efficient use of nitrogenous fertilizers in field situation;
— find out the suitability of the methods.

8b.2 Precaution :

— Conduct the study in rainy season or under irrigated conditions.

8b.3 Materials required :

i. All tools, materials required for raising a successful cereal crop
ii. Neem-cake coated urea
iii. Sulphur coated urea
iv. Super granule urea
v. Urea
vi. Bulky organic manure

8b.4 Procedure :

— Prepare eight plots (25-100 sq. m) for raising crop.
— Apply nitrogen separately in two plots at the rate of 50 kg/ha through the following :
  a) 'Neem-cake' coated urea
  b) Super granules
  c) Urea with bulky manures
  d) Un-treated urea.
— Undertake all the steps essential for raising a good crop i.e. from sowing to harvesting of the crop.

8b.5 Observations :

The pupil should take and record the following observations :

	Treatments	*Colour of the crop*	*Vigour of the plants*	*Yield q/ha (Average of two plots)*
i.	'Neem cake' coated urea			
ii.	Super granule urea			
iii.	Urea with Bulky organic manure			
iv.	Un-treated urea			

8b.6 Expected behavioural outcomes :

The pupil will be able to :

Grade

— apply nitrogen in the field;
— raise a cereal crop;
— find out the response of each method for efficient use of urea.

The teacher should evaluate the pupil for the above abilities.

8b.7 Questions :

i. Can you suggest some other methods ensuring efficient use of nitrogenous fertilizer?
ii. Application of urea with organic manures in-situ or its coating with sulphur/'neem-cake' powder increases the cost of crop production. How is it economical over application of un-treated urea?
iii. Name at least five coating materials.

9. Activity Unit

PREPARATION OF FARM YARD MANURE (FYM)

9.1 Instructional objectives :

The pupil should be able to :

— select site for preparing the pit;
— dig the pit;
— seal the bottom of the pit by conventional methods;
— collect animal dung, litter and urine;
— fill the pit at regular intervals;
— cover the pit for proper decomposition;
— protect the filled pit against atmospheric losses of nutrients from the pit;
— sprinkle water in the pit and turn the contents in it for proper decomposition;
— evaluate the quality of F.Y.M.;
— calculate the approximate quantity of dung and litter available from each cattle and estimate the number of cattle required to fill up one standard sized pit of 3 × 2 × 0.85 m;
— calculate the quantity of F.Y.M. produced from one pit of standard size.

9.2 Relevant information:

9.2.1 What is F.Y.M.?

It is well decomposed dung of cattle along with litter and urine.

9.2.2 Composition of F.Y.M.

F.Y.M. contains 0.5 to 1.5% N, 0.4 to 0.8% P_2O_5 and 0.5 to 0.9% K_2O. In addition to the major nutrients it also contains small quantities of micro-nutrients required for the normal plant growth.

9.2.3 Effect of F.Y.M. application on physical and chemical

properties of soil

Upon application of F.Y.M. to the soil, the nutrients are released slowly and are available to the plant over a long period of time.

In addition to improving the soil fertility status, when applied in large quantities, well decomposed F.Y.M. also improves the structure of the soil by improving the water holding capacity of light soils and better aeration in poorly drained soils.

9.2.4 Why to prepare F.Y.M.?

i. To utilize efficiently the animal dung and litter.
ii. To convert organic forms of nutrients into easily available forms.

9.2.5 What is decomposition?

Decomposition is a process in which mirco organisms like bacteria, fungi, actinomycetes; etc, break down complex organic substances into simpler and available nutrients under favourable atmospheric conditions.

9.2.6 Time required for decomposition

It depends mostly on weather conditions and the type of raw materials used. Generally it ranges from 4 to 6 months.

9.2.7 Criteria for site selection of the manure pit

— A place which is exposed to sunlight for maximum period in the day.
— Nearer to cattle sheds.
— Preferably on a higher elevation.

9.2.8 Size of the pit

The pit should be 3 x 2 x 0.85 m size. However, the length of the pit can be varied depending on the heads of cattle available. The depth should be maintained at 0.85 m so that maximum microbial activity takes place.

9.2.9 Number of pits

It is preferable to have 2 to 3 pits for sequential production of the F.Y.M.

9.2.10 How to make a leak proof bottom

Application of thin layer of coal tar to the bottom makes it

partially leak proof. In case of non-availability of tar, cow dung slurry or mud plaster can be applied in two/three layers. It is also advisable to harden the bottom before putting the sealing layers for better efficiency.

9.2.11 Application of F.Y.M.

F.Y.M. is generally carried to the fields in carts and dumped all over the field in small heaps. It is then spread all over the field. However, care should be taken that the heaps are not left in the field for long time as volatilization loss of nitrogen might take place. The F.Y.M. should be preferably incorporated in the soil by deep ploughing or harrowing immediately.

9.3 Precautions:

— Select the site for pit at an elevated place.
— Ensure proper sealing of bottom of the pit with locally available materials.
— Undertake filling of the pit from one end.
— Undertake watering of the pit at regular intervals to maintain proper moisture to ensure proper decomposition.
— Protect partially filled pit from rain, flood and high temperatures.
— Ensure proper decomposition of the material before it is applied in the field.
— Undertake uniform distribution of F.Y.M. in the field followed by its immediate incorporation in the soil.

9.4 Materials required:

i. Pick axe
ii. Spade
iii. Measuring tape and scale
iv. Baskets
v. Stick or Bamboo
vi. Farm animals' dung
vii. Litter and urine
viii. Coaltar
ix. Cylindrical container

9.5 Procedure:

— Select a proper site for the manure pit.

— Dig a standard size pit (3 x 2 x 0.85 m).
— Collect the dung, litter, urine everyday and put them in the pit from one end in layers of 20-25 cm.
— Put a 1 cm layer of soil after every 2-3 layers of dung.
— Continue to fill the pit in the same way till the contents of the pit are 10-15 cm above the ground level.
— Sprinkle water over the contents of the pit periodically so as to maintain enough moisture in the accumulating mass.
— Cover the pit with soil and dung slurry paste making top of the pit like a dome.
— After every 15-20 days, check the moisture content in the pit by making a hole in the cover with a bamboo stick. Add water through holes if moisture is insufficient. Close the holes with cow dung after adding water every time.
— See that under average conditions the decomposition is complete within 4-5 months.
— Fill the next pit in the same way. Keep the first pit ready for refilling by the time third pit is filled to capacity.

9.6 Observations:

The pupil should observe the F.Y.M. for the following properties and determine the quality of F.Y.M. prepared:

	Properties	*Undecomposed*	*Decomposed*
i.	Odour		
ii.	Texture		
iii.	Colour		
iv.	Pliability		

9.7 Calculations:

(a) The pupil should calculate the approximate number of cattle heads required to fill the pit as under:
i. Area of the pit = 3 × 2 × 0.85 cubic metres = 'A' cubic metres
ii. Approximate volume of dung, urine per cattle in 4 months. = 'B' cubic metres
iii. Approximate number of cattle = A/B heads required to fill the pit

(b) The pupil should also take the weight of F.Y.M. produced per pit.

Weight of F.Y.M. per pit = tonnes

9.8 Expected behavioural outcomes:

The pupil will be able to:

Grade

— select site for the pit;
— dig the pit;
— fill the pit;
— sprinkle water in the pit for proper decomposition;
— evaluate the F.Y.M.;
— calculate the approximate number of cattle required to fill up one standard sized pit of 3×2×0.85m..

The teacher should evaluate the pupil for the above abilities.

9.9 Questions:

i. Why depth of the pit is kept at 0.85 metres?
ii. Why manure pit is dug on slightly higher elevation?
iii. Why bottom of the manure pit should be *pucca*?
iv. What are the criteria to determine whether the F.Y.M. is ready for application or not?
v. What happens if the F.Y.M. is left as heaps in the field for sometime before broadcasting?
vi. What happens if undecomposed F.Y.M. is applied in the field?
vii. What will be the approximate quantity of N.P.K. in one tonne of F.Y.M.

10. Activity Unit

COMPOST MAKING

10.1 Instructional objectives:

The pupil should be able to:

- make better use of farm and animal wastes;
- convert nutrients into available form;
- ensure cleanliness in the surrounding;
- identify organic waste materials for compost making;
- select proper site for compost making;
- estimate the size and number of compost pits for cyclic preparation of compost;
- collect waste materials and fill the pits;
- sprinkle water for proper decomposition of organic materials;
- evaluate the compost quality.

10.2 Relevant information:

10.2.1 What is compost making?

It is a process of converting farm organic waste materials into a rich source of plant nutrients. It is obtained through decomposition of plant residues and other organic matters including farm waste materials in a pit under set temperature and moisture conditions. Compost provides not only essential nutrients to the crops, but also improves physical condition of the soil. Ordinary compost can be enriched with nitrogen and phosphorus through Azotobacter and Superphosphate, respectively.

10.3 Precautions:

- Estimate the average quantity of waste material daily available for compost making.
- Determine the number of pits according to the availability of the waste material.

— Select appropriate site for compost pits.
— Fill the pits systematically and seal them well.

10.4 Materials required:

i. Pick axe
ii. Spade
iii. Measuring tape
iv. Baskets
v. Stick or bamboo
vi. Farm/village/city organic waste material.

10.5 Procedure:

— Collect the waste material daily for a few days and determine the average quantity of waste material available for compost making. Accordingly determine the number of compost pits to be dug taking 3 x 2 x 0.85 m as the standard size of a pit.
— Select appropriate site for compost pit. It should be close to cattle sheds but should be away from the local source of water. It should be exposed to the sun. Rain water should not accumulate there.
— Dig three pits of 3 x 2 x 0.85 m size adjacent to each other. Make their bottom *pucca* or partially *pucca*.
— Collect organic waste material daily. Deposit it in the pit in layers of 20-25 cm. If necessary, organic material should be chopped to small size. Begin deposition from one end of the pit. When two or three such layers are deposited in the pit, spread cow dung slurry (1 : 10 ratio) and soil over them in a layer of 2 to 2.5 cm thickness. It is not necessary to have soil layer, if the organic waste already contains fairly good amount of soil.
— Continue to fill the pit in the same way till it is filled upto the top.
— Add water to the pit from time to time so as to maintain enough moisture for proper decomposition of the waste material. Cover the pit with soil and dung paste when it is filled to capacity.
— One month after covering the pit, remove a small portion of the soil cover and check moisture condition in the pit. In case of insufficient moisture make a few holes in the soil cover with the help of some stick or bamboo and pour water through

them. Then seal them with a paste of cowdung and soil.

— When the first compost pit is filled to capacity, start depositing waste material in the second pit in the same way. Follow the same procedure for third pit. Take out compost. (which is ready by this time) from the first pit when it is ready.

10.6 Observations:

The pupil should observe the compost for the following properties and determine the quality of compost prepared:

	Properties	*Undecomposed*	*Decomposed*
i.	Odour		
ii.	Texture		
iii.	Colour		
iv.	Pliability		

10.7 Expected behavioural outcomes:

The pupil will be able to:

Grade

— select site for the pit;
— dig the pit;
— fill the pit;
— sprinkle water in the pit for proper decomposition;
— evaluate the compost.

The teacher should evaluate the pupil for the above abilities.

10.8 Questions:

1. Which of the following are better suited for direct application in the field and why?
   a. Wheat bhusa
   b. Cowdung
   c. Raw undecomposed leafy materials
   d. Compost

ii. How to determine the moisture condition in the covered compost pit?

iii. Why soil layer is laid in between layers of organic waste in the compost pit?

iv. How the quality of the compost varies?

v. What are the materials used for compost making?

11. Activity Unit

SUPER COMPOST MAKING

11.1 Instructional objectives:

The pupil should be able to:

- reduce loss of nitrogen from the compost;
- increase efficiency of phosphorus utilization particularly in the acidic soils;
- increase nutrient value of compost;
- prepare super compost;
- study the effect of super compost on plant growth.

11.2 Relevant information:

11.2.1 Super composting, why?

During the course of compost making considerable amount of nitrogen is lost as ammonia from the composting material. Proper covering (sealing) of compost pit prevents this loss to some extent. This loss is better minimised by adding some preservatives in the compost pit. Gypsum and superphosphate are commonly used for this purpose as they absorb ammonia and do not let it escape. The percentage of phosphorus in the compost increases and so increases the efficiency of phosphorus utilization, particularly in the acidic soils. When superphosphate is used during compost making it is called *super compost.*

11.3 Precautions:

Refer to para 10.3

11.4 Materials required :

Refer to para 10.4 plus single superphosphate. The quantity of single superphosphate added to waste materials should be in the ratio of 1 : 100.

11.5 Procedure:

— Divide the pit into three equal sections.
— Fill the first section with waste materials in layers of 20-25 cm.
— Sprinkle the estimated quantity of single superphosphate over each layer of organic waste material.
— Continue filling the pit in this way to its capacity. Maintain proper moisture condition in the pit; cover the pit and take all necessary steps for proper decomposing in the same way as in case of compost making. Super compost is ready after 3-4 months depending upon environmental conditions.

11.6 Observations:

(a) The pupil should observe the super compost for the following properties and determine the quality of super compost prepared:

	Properties	*Undecomposed*	*Decomposed with superphosphate*
i.	Odour		
ii.	Texture		
iii.	Colour		
iv.	Pliability		

(b) The pupil should also study the effect of ordinary compost and super compost on plant growth, if possible. This study can be undertaken in nine pots by taking measured quantity of soil with following three treatments:
   i. Only soil (No compost or super compost)
   ii. Soil+ordinary compost (1% of the soil by weight or volume)
   iii. Soil + super compost (1% of the soil by weight or volume)

Repeat the same treatments in three pots. Hence nine pots will be required. Sow four seeds of any cereal or legume crop (Maize/Jowar/Green gram/Black gram). Apply required quantity of water daily or after an appropriate interval of time depending upon

ıent. Raise the crop for 2 months. Record the following
:

Treatments	*Weight of dry matter in g/pot (Average of three pots)*
Only soil	
Soil + ordinary compost	
Soil + super compost	

d behavioural outcomes:

)il will be able to:

Grade

ıre super compost;
ate super compost;
' the effect of ordinary compost and super
)ost on plant growth;
)rehened the utility of super composting.

:her should evaluate the pupil for the above abilities.

s :

is super compost better than ordinary compost?
much superphosphate should be added to make super
)ost from 1 tonne manure?

12. Activity Unit

AZO-COMPOST MAKING

12.1 Instructional objectives:

The pupil should be able to:
- explain the role of Azotobacter in nitrogen fixation;
- incorporate Azotobacter in compost;
- prepare azo-compost;
- increase nitrogen content of compost;
- study the effect of azo-compost on plant growth.

12.2 Relevant information:

12.2.1 What is azo-compost?

Compost prepared by using nitrogen fixing bacteria is called azo-compost. The content of NPK in compost varies depending upon the composition of the composting material.It is more in town compost (1.4, 1.0, 1.4%) in comparison with the farm compost which contains about 0.5% N, 0.15% P_2O_5 and 0.5% K_2O. Nitrogen content of the compost increases upto 1.5% if some nitrogen fixing micro organisms are made to flourish in the compost pit. Azo-compost is the cheapest source in nitrogen among all organic manures.

12.3 Precautions:

- Procure the viable Azotobacter packets only. Check the expiry dates mentioned on them.
- Store Azotobacter packets in dark, dry and cool places as indicated on the packets.
- Open Azotobacter packets just before application.

12.4 Materials required:

Refer to para 10.4 plus required azotobacter packets (Fig. 12.4).

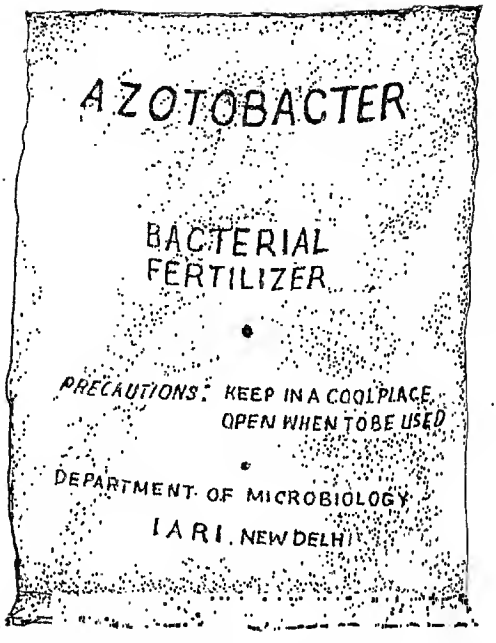

Fig. 12.4. A PACKET OF AZOTOBACTER CULTURE

12.5 Procedure:

— Fill the compost pit sectionally as in the case of super compost.
— Mix Azotobacter culture with fine compost powder and sprinkle evenly over the 20-25 cm thick layer of composting material in the section.
— Repeat the above step till the pit is completely filled.
— Cover the pit.
— Take all steps necessary for proper decomposition of the compost as indicated in Activity Unit 10.

12.6 Observations:

(a) The pupil should observe the azo-compost for the following properties and determine the quality of azo-compost prepared:

Properties	*Undecomposed*	*Decomposed with Azotobacter*
i. Odour		
ii. Texture		
iii. Colour		
iv Pliability		

(b) The pupil should also study the effect of ordinary compost and azo-compost on plant growth, if possible. This study can be undertaken in nine pots by taking measured quantity of soil with following three treatments.

i. Only soil (Without ordinary compost or azo-compost)
ii. Soil+ordinary compost (1% of the soil by weight or volume).
iii. Soil+azo-compost(1% of the soil by weight or volume).

Repeat the same treatment in three pots. Hence, nine pots will be required. Sow seeds of any cereal or legume crop (Maize/jowar / green gram/black gram). Apply required quantity of water daily or after an appropriate interval of time as per requirement. Grow the crop for 2 months. Record the following observations:

Treatment	*Weight of dry matter in g/pot (Average of three pots)*
i. Only soil	
ii. Soil + ordinary compost	
iii. Soil + azo-compost	

12.7 Expected behavioural outcomes:

The pupil will be able to:

— prepare azo-compost;
— evaluate azo-compost;
— study the effect of ordinary compost and azo-compost on plant growth;
— comprehend about the utility of azo-compost.

Grade

The teacher should evaluate the pupil for the above abilities.

12.8 Questions:

i. Why azo-compost should be preferred over simple compost?
ii. Can Azotobacter live in the compost pit?
iii. What will happen if we apply Azotobacter directly in the field like any fertilizer?
iv. What specific precautions are required while preparing Azo-compost?
v. What is the advantage of adding Azotobacter into the Compost Pit?

13. Activity Unit

GREEN MANURING

13.1 Instructional objectives:

The pupil should be able to:

- explain the importance of green manure crop;
- inoculate green manure crop seeds with suitable Rhizobium culture;
- raise a green manure crop;
- decide the stage of crop for incorporation in the field;
- incorporate green manure crop in the field;
- study the effect of green manuring on the bulk density and C/N ratio of the soil.

13.2 Relevant information:

13.2.1 What is Green Manuring?

Raising of a crop in the field and incorporating it in its green stage in the same field is called *Green Manuring*. The term *Green Leaf Manuring* is used when green leafy matter is brought from outside and incorporated in the soil.

13.2.2 What is a Green Manure crop?

A crop which produces abundant green matter and is grown exclusively for incorporation in soil is called a *green manure* crop.

13.2.3 Importance of Green Manuring

In the present days of non-availability of sufficient quantities of bulky organic manures, green manuring helps us in a big way to circumvent this problem to a certain extent. These crops can be grown under the conditions of limited moisture and fertility. Besides addition of organic matter, green manuring also supplies available nutrients to the next crop and increases moisture retention capacity of the soil.

13.2.4. Green manure crops and their effects

Usually quick growing leguminous crops with profuse foliage are recommended for green manuring. These crops add considerable quantity of organic matter (upto 8 t/ha) to the soil in addition to about 40 kg of nitrogen/ha, of which about 2/3 is fixed from atmosphere by the bacteria living in the nodules on the roots of leguminous crops. Several crops are recommended for green manuring like sunhemp, *dhaincha,* berseem and even pulse like black gram, green gram, *guar* and lobia. Of all these crops, sunhemp is the most widely accepted crop for green manuring. Organic matter of the sunhemp green manuring crop contains 0.5-0.7% nitrogen, 0.1-0.2% phosphate and 0.8-1.6% potash. Efficiency of green manuring crops increases considerably if their seeds are inoculated with bacterial culture like Rhizobium immediately before sowing.

13.2.5 When to grow a green manure crop?

Whilst there is no hard and fast rule when it should be grown, generally it is cultivated during Kharif and incorporated for the benefit of Rabi crop under wet weather conditions(1000 to 1500 mm rain fall) and in some areas cultivated after the main crop with the residual moisture for the benefit of the succeeding crop in the dry weather conditions (upto 750 mm rain fall).

13.2.6 When to incorporate

The stem of the plants should not be woody and should be incorporated just before flowering. Depending on the weather conditions, it is ideal to incorporate when the soil is having good moisture.

13.2.7 How to incorporate?

The crop should be incorporated 20-30 cm deep into the soil with a tractor or at least with a mould board plough such that the green matter is completely incorporated in the soil.

13.2.8 Time required for decomposition

The crop should be incorporated giving at least 1-2 months interval before the succeeding crop (it varies from crop to crop) is sown.

13.3 Precautions:

— Incorporate the crop or green matter at the correct stage.
— Ensure proper and deep incorporation of green matter.

— Give sufficient time for decomposition before planting the succeeding crop.

13.4 Materials required:

i. All tools and implements required for raising a green manure crop (Mould board plough for incorporation is essential).
ii. Green manure crop seeds
iii. Rhizobium culture
iv. Super phosphate

13.5 Procedure:

— Prepare plot for sowing.
— Broadcast super phosphate @ 100 kg/ha.
— Take seeds of sunhemp or any green manuring crop suitable to your cropping pattern and area and just a day before sowing treat them with Rhizobium culture (for details of the treatment, see Sub Unit: 15 a).
— Broadcast the seeds uniformly throughout the field having sufficient moisture for proper germination. A dense uniform plant stand reduces weed population and ensures much tender plants for better decomposition.
— Plough down the crop with mould board plough just before flowering when the stem is still not woody.

13.6 Observations:

The pupil should observe the gradual changes taking place in the soil after incorporation of green manuring crop into it. For this purpose random soil samples from 0-20 cm depth should be taken from the field after every 15 days. Such a continuous observation will give pupil a distinct picture of the process of decomposition of organic matter. The pupil can identify a number of intermediate stages between fully decomposed and undecomposed organic matter in the soil samples. Two extreme stages are characterized as below:

i. Decomposed—Mixed with blackish brown crumbling material.
ii. Undecomposed—Mixed with stringing gummy blackish green materials.

Besides, stage of complete decomposition can be determined by estimating C:N ratio of the soil. If C:N ratio is about 10-15:1, organic residues are present in decomposed form. The pupil may determine C:N ratio by analysing soil samples for carbon and nitrogen. Procedures for the determination of these two nutrients are given in the Instructional-cum-practical manual on 'Soil and its properties'. The pupil should record C:N ratio and find out the stage of decomposition of organic residue in the soil.

Time after incorporation	*Characteristics of organic residues*	*C:N ratio*
—Just after incorporation		
—After 15 days		
—After 30 days		
—After 45 days		
—After 60 days		

13.7 Expected behavioural outcomes:

The pupil will be able to:

Grade

— treat green manure crop seeds with Rhizobium culture;
— apply super phosphate;
— raise the green manure crop;
— incorporate the green matter in the soil;
— undertake carbon and nitrogen determination in the soil;
— judge the stage of decomposition.

The teacher should evaluate the pupil for the above abilities.

13.8 Questions:

i. What happens if woody branches are incorporated into the soil?
ii. What is the ideal time of incorporation of green manure crop?
iii. How do you determine whether the green manure has decomposed or not?
iv. What happens if the green manure does not decompose fully?
v. Why are only leguminous crops preferred for green manuring?

14. Activity Unit

CONCENTRATED ORGANIC MANURES AND THEIR EFFECT ON CROP GROWTH

14.1 Instructional objectives:

The pupil should be able to:

— differentiate between oil cakes, fish meal and slaughter house refuse;
— recall the nutrient content of various concentrated organic manures;
— study the effect of some of these manures on plant growth;
— recall the proper time and method of use of these manures.

14.2 Relevant information:

14.2.1 What are concentrated organic manures

These are some of the unconventional, not so widely used organic manures having special importance for several horticultural crops including indoor ornamental plants and kitchen gardening.

Concentrated organic manures are organic in nature and contain higher percentage of major plant nutrients such as nitrogen, phosphorus and potash. Hence, these are required to be applied in lesser quantities than that of bulky organic manures. Plant nutrient content present in concentrated organic manures are also in organic combinations as in bulky manures. Therefore, the nutrients are liberated in available form only after mineralization. But due to their C:N ratio of 3 to 15 they nitrify readily. Therefore, these are quick acting materials.

14.2.2 Types of concentrated organic manures

OIL CAKES :

Oil cakes are the residue left after the oil is extracted from oil

bearing seeds. The manurial value of oil cakes lies mainly in its nitrogen content though it contains small quantities of phosphorus, potash and traces of micro nutrients as well (table 14.2.1)

Generally nitrogen becomes available in about 10-20 days after application except in '*Mahua cake*' which release nitrogen after about 2 months of application. Oil cakes should be well pulverised for their quick decomposition before use.

BLOOD MEAL :

Dried blood or blood meal is prepared after its collection in slaughter houses.

FISH MEAL :

Non-edible fish and carcasses of fish are used to prepare fish meal. The fish is dried, crushed or powdered and filled in bags.

HORN AND HOOF MEAL :

Horns and hoofs after cooking in the bone digester are taken out, dried and powdered.

BONE MEAL :

Most of the bone meal sold in the market consists of crushed untreated raw bones. The bones sometimes are first treated with steam to remove fat before they are crushed. Steamed bones are more brittle and easy to crush and at the same time they decompose more readily than the raw bones and increase phosphorus and lime contents. It also increases the citric acid solubility of calcium phosphate of bones. Bonemeals are most suited to acid soils.

Table 14.2.1

Average nutrient content of principal concentrated organic manures.

Name of the manure	*Per cent compostion*		
	N	P_2O_5	K_2O
Non-edible oil cakes			
i. Castor cake	4.3	1.8	1.3
ii. Cotton seed cake (Undecorticated)	3.9	1.8	1.6
iii. *Karanj* or honge cake	3.9	0.9	1.2
iv. *Mahua* cake	2.5	0.8	1.8
v. Neem cake	5.2	1.0	1.4
vi. Safflower cake (Undecorticated)	4.9	1.4	1.2
vii. Undior Punna cake	3.6	1.5	2.0

Name of the manure	*Per cent composition*		
	N	P_2O_5	K_2O
Edible oil cakes			
i. Coconut cake	3.0	1.9	1.8
ii. Cotton seed cake (decorticated)	6.4	2.9	2.2
iii. Groundnut cake	7.3	1.5	1.3
iv. Linseed cake	4.9	1.4	1.3
v. Jambo cake	4.9	1.6	1.9
vi. Niger cake	4.7	1.8	1.3
vii. Rape seed cake	5.2	1.8	1.2
viii. Safflower cake (decorticated)	7.9	2.2	1.9
ix. Sesame cake	6.2	2.0	1.2
Other concentrated organic manures			
i. Bloodmeal	10.0	1.5	1.0
ii. Fishmeal	4 to 10	3 to 9	0.3 to 1.5
iii. Hoof & Horn meal	10 to 15	1.0	—
iv. Raw bonemeal	3 to 4	20.0	
v. Steam bonemeal	0.0	22.0	

14.3 Precautions:

Based on the type of concentrated manure take appropriate precautions:

- —Ensure that the manure is powdered well.
- —In case of *'mahua cake'* apply 2 months prior to planting/sowing.
- —Apply it uniformly over the entire field.
- —Apply in-situ for better efficiency.
- —Take appropriate measures against soil grubs which tend to get attracted by oilcakes.

14.4 Materials required:

i. Measuring tape
ii. Tools for field preparation, hoeing, weeding and harvesting.
iii. Seed-cum-fertilizer drill/fertilizer drill/plough with seed tubes.
iv. Seeds of a crop (Maize/Jowar/Paddy).
v. Powdered cakes or any available concentrated organic manure.
vi. Irrigation facilities.

14.5 Procedure:

— Demarcate 100 sq.m plot in the field.
— Prepare the plots for sowing.
— Divide the plot in two equal halves (A and B)
— Select the concentrated organic manure giving due consideration to its economics, availability and suitability to the crop.
— Calculate the quantity of the concentrated organic manure that may supply half of the total nitrogen requirement of the crop.
— Powder it well.
— In plot 'A' apply it either through (i) broadcasting uniformly in the field or through (ii) localized placement in the plough furrows or (iii) drilling with the help of a seed-drill or the local sowing attachment with the deshi plough. In case of horticultural crops, apply it as per practices followed for the particular crop. In case of field and plantation crops apply it a week before sowing, but for horticultural crops its application should be as per specific manuring schedules and cultural practices.
— Apply 50% of the remaining half of the total quantity of nitrogen through any nitrogenous fertilizer like urea in the same plot "A".
— Apply 100% of the nitrogen requirement through any nitrogenous fertilizer like urea in the plot 'B'.
— Sow the seeds with seed drill or dibble them in the plot 'B'.
— Take all agronomic measures necessary to raise a good crop in both the plots including top dressing of crop with remaining quantity of nitrogen requirement through urea in plot "A".
— Harvest the crop separately at appropriate maturity stage.
— Weigh the produce (dry matter as well as grains) separately from both the plots.

14.6 Observations:

The pupil should take the following observations and record them as below:

Indices	*Plot 'A' (concentrated manure + nitrogenous fertilizer)*	*Plot 'B' (nitrogenous fertilizer only; no concentrated manure)*
i. Height of plant at one month stage.		
ii. Colour of the plants at one month stage		
iii. Yield of dry matter (kg/ha)		
iv. Yield of grain (kg/ha)		

14.7 Expected behavioural outcomes:

The pupil will be able to:

Grade

— identify the concentrated manures and know their composition;
— differentiate between various concentrated manures;
— grind and apply concentrated manures;
— evaluate the effectiveness of concentrated manures on plants and their growth.

The teacher should evaluate the pupil for the above abilities.

14.8 Questions:

i. Which are the plant nutrients mainly present in oil cakes?
ii. Which cake takes longer time to supply nutrients to crop?
iii. How will you apply oil cakes?
iv. Which is the important plant nutrient present in bone meal?
v. Why steamed bone meal does not contain nitrogen?
vi. Why is steamed bone meal superior over unsteamed bone meal.

15. Activity Unit

USE OF BIO-FERTILIZERS

15.1 Instructional objectives:

The pupil should be able to:
— recall the importance of various bio-fertilizers;
— use various bio-fertilizers correctly under field conditions.

15.2 Relevant information:

15.2.1 What are bio-fertilizers?

The term biofertilizer refers to preparations containing active strains of the micro-organisms in sufficient numbers. They are used either to fix atmospheric nitrogen or to solubilize plant nutrients like phosphate or to otherwise stimulate plant growth through synthesis of growth promoting substances. In addition to bacteria, blue-green algae have also been found to fix atmospheric nitrogen, if they are inoculated into the soil and established in paddy fields.

15.2.2 Atmospheric nitrogen and its fixation

The atmosphere contains about 78 per cent elemental nitrogen. In other words about 8500 tons of nitrogen is present over an area of one hectare of land. However, crop plants cannot make use of this elemental nitrogen. The atmospheric nitrogen under natural course is being fixed in soil through two process:

i. through rain water (contributing hardly 2 to 20 kg N/ha per annum).
ii. biological nitrogen fixation.

Biological nitrogen fixation has been and will continue to be one of the most important factors in maintaining nitrogen balance in soil. The micro-organism that fix nitrogen are classified into two groups:

i. Symbiotic microbes
   Example : Root nodule bacteria-Rhizobium

ii. Non-symbiotic microbes

Examples: (a) Azotobacter-aerobic bacteria
(b) Blue green algae under waterlogged soils
(c) Azolla a floating aquatic fern associated with blue green algae

15.2.3 Phosphate solubilizing bacteria

Phosphobacteria (*Bacillus megatherium* var. *Phosphaticum*) on the other hand solubilize the organic as well as inorganic phosphate.

15.2.4 Quantum of nitrogen fixation

i SYMBIOTIC FIXATION :

Legumes with the help of Rhizobia can use inert atmospheric nitrogen. The efficiencyof nitrogen fixation through this symbiotic association could be improved by inoculating the legumes with the most efficient strains of bacteria and creating favourable conditions for their activity. Legumes under favourable conditions can fix from 40 to 194 kg/ha/year (Table 15.2.4) of elemental nitrogen from the atmosphere. An appropriate inoculum and adequate root nodulation can meet 80 per cent of the nitrogen needs of legumes through Rhizobial symbiosis.

Table : 15.2.4 Magnitude of nitrogen fixed by certain legumes

Legume crop	*Nitrogen fixed (kg/ha/year)*
Alfalfa	194
Cowpea	90
Peas	72
Sunhemp	58
Beans	40
Berseem	120
Red gram	40
Groundnuts	42

ii. NON-SYMBIOTIC FIXATION :

(a) Azotobacter : Fixation of atmospheric nitrogen by micro-organism in a free state is known as non-symbiotic fixation. One of the well known free living heterotrophic fixation. One of the well known free living autotrophic bacteria in this category is Azotobacter. These bacteria utilize the

atmospheric nitrogen for their protein synthesis and on their death the protein to assimilated is mineralized in the soil contributing towards enrichment of the soil. Azotobacter can fix nitrogen to the extent of 10 to 15 kg N/ha. Azotobacter secrets some growth promoting substances which enhance growth of the crop plant.

(b) Free living blue-green algae : The blue green algae under submerged paddy field can fix atmospheric nitrogen upto 30 kg N/ha per year, although nitrogen fixation through algae culture ranging from 40 to 80 kg N/ha/yr have been recorded at International Rice Research Institute, Philippines.

(c) Azolla: Azolla (*Azolla pinnata*) is a floating aquatic fern. Azolla produces a remarkable quantity of biomass to the extent of about 30-40 tonnes/ha/year containing 4 to 5 per cent nitrogen on dry weight basis. It has been estimated that 30 kg N/ha could be saved for rice crop with the incorporation of Azolla @ 10 tonnes of fresh biomass per hectare.

Azolla can be cultivated in small beds filled with water upto 6" to 9" depth and fertilized with 6 to 16 kg P_2O_5/ha through super phosphate. Azolla plants could be procured from the adjacent tanks or ponds for multiplication in beds.

15.2.5 Use of Bacterial cultures

Usually 400 g of peat or lignite based culture or 900 g of soil based culture would be sufficient for the quantity of crop seed required per hectare.

Specification: Azotobacter plus phosphobacterin inoculants for cereals and Rhizobium plus phosphobacterin inoculants for legumes.

15a. Sub Unit : **Inoculation of Seeds with Bacterial Fertilizers**

15 a. 1 Instructional objectives:

The pupils should be able to:

— prepare the gur slurry for bacterial inoculation;

— inoculate the seed with inoculant uniformly.

15 a. 2 Precautions:

— Procure the bacterial cultures under ordinary conditions, 15 to 20 days prior to sowing.
— Keep the packets of bacterial culture in cool place to protect from direct sunlight.
— Inoculate the seeds in shade or during night hours.
— Undertake sowing of treated seeds as early as possible.
— Use the packets immediately once opened.
— Avoid the inoculated seeds from coming in direct contact with fertilizers/insecticides.

15 a. 3 Materials required:

i. Gur/Jaggary
ii. Bacterial culture
iii. Tray
iv. Seeds
v. Heater/stove

15 a. 4 Procedure:

— Dissolve 100 g of gur in half litre of water.
— Boil the content till a thick solution is obtained.
— Let the solution sufficiently cool.
— Add suitable quantity of the inoculant to the solution. In general one packet of Azotobacter/Rhizobium and one packet of Phosphobacterin is recommended for an acre of land.
— Mix the inoculant thoroughly and sprinkle it on the seed to be sown and stir the seeds in such a manner that each seed is coated with the bacterial inoculant.
— Spread the treated seeds on a clean cloth/floor under shade to dry up.
— If it is desired to keep the seeds for few days or if the sowing is to be done in saline/alkali situations then the wet bacterial dressed seeds should further be coated with gypsum/lime/calcium carbonate.

15 a. 5 Observations:

The pupil should undertake the following observations:
i. Viscosity of the gur/jaggary slurry

ii. Quantity of the slurry used for moistening the seeds
iii. Uniform coating of the seeds with bacterial inoculum

15 a. 6 Expected behavioural outcomes:

The pupil will be able to:

Grade

— prepare gur slurry;
— inoculate seeds;
— dry the inoculated seeds.

The teacher should evaluate the pupil for the above abilities.

15 a. 7 Questions:

i. Enumerate non-symbiotic micro-organisms fixing atmospheric nitrogen.
ii. What is the best method for applying the bacterial inoculants and why?
iii. What do you mean by heterotrophic organisms?
iv. What is the role of phosphobacterin in soils?

15b. Sub Unit : **Use of Blue-Green Algae**

15 b. 1 Instructional objectives:

The pupil should be able to:
— culture blue-green algae;
— apply the algae culture in the paddy field correctly.

15 b. 2 Relevant information:

— *Source of blue-green algae*

The 'starter culture' multiplication of blue-green algae can be obtained from recognised supplying centres like Agricultural Universities, IARI, etc.

15 b. 3 Precautions:

— Prevent breeding of mosquito and other insects in trays by using Folidol (0.001 ppm) or Parathion (0.00075 ppm) or

Carbofuron (3% granules, @ 25 g/tray).
— Do not allow the water to dry up in the tray while growing the algae culture.
— Expose the tray to the sun.
— Do not store the algal material in direct contact with chemical fertilizer or other agricultural chemicals.

15 b. 4 Materials required:

i. Galvanized iron trays or brick and mortar structures of 2x 1 x 0.23 m size.
ii. Superphosphate
iii. Sodium molybdate
iv. Starting culture of blue-green algae
v. Neutral soil

15 b. 5 Procedure:

The details of multiplication of blue-green algae from the starter culture are as follows:

— Procure/prepareshallow trays (2 x 1 x 0.23 m) of galvanized iron sheet or brick and mortar structure (only when permanent units are desired).
— Place 8-10 kg soil (Loamy, the pH should be preferably around neutral) in the tray and mix it well with 200 g of superphosphate and 2 g of sodium molybdate.
— Fill the tray with 0.05 to 0.15 cm water, depending upon the local conditions and rate of evaporation and allow the soil to settle down in the tray.
— Sprinkle the starter culture on the surface of the clear standing water.
— Keep the tray in the upon air completely.
— In hot summer months, the growth of the algae in the trays is rapid and in about 7 days they form a thick mat on the soil surface and some times float up.
— If the daily rate of evaporation is high, add water to the trays intermittently. When the algal growth becomes sufficiently thick, stop watering.
— Allow the water in the trays to dry up in the sun.
— Collect the dry algal flakes from the surface or scrap them off and store them in bags for use in fields.
— Fill the tray again with water and add a handful of the dry

algal flakes to the trays as further inoculum. Continue the process as above round the year if required. Usually 3-4 harvests could be taken from a single tray.

A single harvest of surface algae from one tray of the above dimention (2 x 1 x 0.23 m) will give about 1.5 to 2 kg of algal material.

— Broadcast the dried algal material over the standing water in the field at the rate of 8-10 kg per hectare, one week after transplantation.

15b. 6 Observations:

The pupil should undertake the following observations:

i. Maintenance of appropriate level of water in trays
ii. Growth of algae after 7 days of sprinkling of starter culture
iii. Growth of blue-green algae in paddy field.

15b. 7 Expected behavioural outcomes:

The pupil will be able to:

— prepare trays for the growth of blue-green algae;
— sprinkle the starter culture on the surface of the clear standing water;
— broadcast the dried algal material in the paddy field.
— distinguish Azolla and blue-green algae.

Grade

The teacher should evaluate the pupil for the above abilities.

15b. 8 Questions:

i. Name the crops for which blue-green algae and Azolla have agricultural significance.
ii. What type of organism is active in Azolla for fixing atmospheric nitrogen?

Appendix-I

COMPOSITION OF SOME IMPORTANT FERTILIZERS MANUFACTURED IN INDIA

	Category	Composition (per cent nutrient)		
I.	Nitrogenous			
	(1) Ammonium sulphate	20.6 N		
	(2) Ammonium chloride	25.0 N		
	(3) Calcium ammonium nitrate	25.0 N		
	(4) Urea	46.0 N		
II.	Phosphatic			
	(1) Single superphosphate	16.0 P_2O_5		
	(2) Triple superphosphate	46.0 P_2O_5		
	(3) Rockphosphate (as a fertilizer)	20-25 P_2O_5		
III.	N.P. Fertilizer	N	P_2O_5	
	(1) Diammonium phosphate	18.0	46.0	
	(2) Nitrophosphates	20.0	20.0	
	(3) Ammonium phosphate sulphate	16.0	20.0	
	(4) Urea ammonium phosphate	28.0	28.0	
IV.	NPK Complex fertilizers	N	P_2O_5	K_2O
		15	15	15
		19	19	19
		17	17	17
		12	32	16
		10	26	26
		14	35	14
		14	28	14
	Some Important Fertilizers Not manufactured in India			
V.	Potassic			
	(1) Muriate of potash	60.0 K_2O		
	(2) Sulphate of potash	50.0 K_2O		

Appendix-II

COMPOSITION OF GREEN MANURING CROPS AND GREEN LEAFY MATERIALS

Material		*% (oven-dry basis)*		
		N	*P*	*K*
Sesbania aculeata	Range	1.86-2.80		
	Mean	2.18		
Sesbania speciosa	Range	2.20-2.90		
	Mean	2.51		
Sesbania sericia		2.20		
Sesbania aegyptiaca (Leaves)		4.00	0.19	2.00
Crotalaria juncea (sunhemp)	Range	1.52-3.01		
	Mean	1.95		
Crotalaria striata		3.90		
Crotalaria retusa (leaves)		2.89	0.29	0.72
Cyamposis tetragonoaloba	Range	1.20-3.50		
(Cluster bean)	Mean	1.76		
Vigna sinensis (Cowpea)	Range	2.28-3.50		
	Mean	3.09		
Vigna mungo (Black gram)		2.23		
Melilotus indica	Range	1.76-2.04		
(Leaves only)		3.36		
Phaseolus aureus (Green gram)		2.11		
Dolichos biflorus (Horse gram)		1.16		
Lens esculentus (Lentil)		2.00		
Indigofera tinctoria (Indigo)				
Leaves only		5.11	0.34	1.38
Prosopsis juliflora (Leaves)		5.07	0.40	2.58
Cassia occidentalis				
(Leaves & Stems)		2.80-4.91	0.20	1.87
(Leaves only)		5.90	0.49	2.64
Cassia fistula (leaves)		3.30	0.31	1.65
Cassia siamea (Leaves)		1.91	0.18	1.03
Tephrosia purpurea (Leaves)		3.73	0.28	1.78
Gliricidia maculata		4.15	0.27	3.00
Lathyrus sativus (Chickling vetch)	Range	1.93-4.67		
	Mean	3.30		
Tamarindus indica (Leaves)		1.59	0.19	1.10
Azadirachta indica (Leaves)		2.38	0.20	1.30

Leucaena leucocephala (Leaves & Stems)		1.5	0.2	1.2
Caesalpinia pulcherrima (Leaves)		3.11	0.36	1.29
Albizzia lebbeck (Leaves)		3.81	0.13	0.94
Acacia ferruginea (Leaves)		2.96	0.13	0.88
Dalbergia sisso (Leaves)		2.48	0.26	1.71
Moringa pterygosperma (Leaves)		3.83	0.26	2.22
Calatropis sp. (Leaves)		2.98	0.30	0.85
Jacarnda mimosaefolia (Leaves)		2.15	0.19	0.86
Tecoma stans (Leaves)		1.86	0.19	0.92
Lucerne *(Medicago sativa)*		2.55		
AQUATIC WEEDS & ALGAE				
Water hyacinth	Range	1.03-3.70	0.10-0.63	1.81-4.40
	Mean	2.04	0.37	3.40
Azolla sp.		3.68	0.20	0.15

Appendix-III

FERTILIZER RECOMMENDATIONS FOR VARIOUS CROPS

Sr. No.	Crop	N	P_2O_5 (kg/ha)	K_2O
***KHARIF* CROPS**				
1.	Sorghum	80	40	40
2.	Bajra	60	30	30
3.	Paddy	100	50	50
4.	Maize	100	75	75
5.	Cotton (Irrigated)	100	50	50
	Cotton (Rainfed)	50	25	25
6.	Groundnut	25	50	25
7.	Sunflower	40	20	20
8.	Castor	60	40	—
9.	Seasamum	50	25	—
10.	Tur (Pigeonpea)	25	50	—
11.	Green gram	25	50	—
12.	Black gram	25	50	—
***RABI* CROPS**				
13.	Sorghum	50	25	—
14.	Wheat (Irrigated)	100-120	50	50
	Wheat (Rainfed)	40	20	—
15.	Safflower	30	20	—
16.	Linseed	25	25	—
17.	Gram	25	50	—
IRRIGATED CROPS				
18.	Summer Groundnut	25	50	25
19.	Sugarcane (Adsali)	350	170	170
	Sugarcane (Pre-seasonal)	300	170	170
	Sugarcane (Seasonal)	250	115	115

The recommendations may vary from place to place depending upon the variety of the crop and availability of irrigation.

Half of N is applied at the time of sowing. Remaining half is either applied after 25-30 days of sowing or in two equal split doses at 20-30 days after sowing and at 55-60 days after sowing of the crop

depending on the crop requirement at different growth phases. For legume crops, complete N is applied at the time of sowing. In Sugarcane (preseasonal and seasonal) N is applied in two or three split doses upto 110-120 days and upto 180 days in case of Adsali sugarcane. Phosphorus and potash are applied at the time of sowing/planting of the full crop.

Appendix-IV

CARBON-NITROGEN RATIOS OF SOME ORGANIC MATERIALS

Material	*C/N ratio*	*Material*	*C/N ratio*
Farm residues		**Human habitation wastes**	
Rice straw	80-130	Nightsoil	6-10
Wheat straw	80-130	Urine	0.8
Barley straw	100-120	Digested sludge	6
Maize stalks & leaves	50-60	Biogas slurry (ex-cattle dung)	20
Cotton stalks	70	**Vegetable residues**	
Sugarcane trash	110-120	Potato tops	27
Lucerne residues	19	Cabbage	12
Green weeds	13	Onion	15
Water hyacinth	18	Pepper	15
Red clover	19	Tomato	12
Flax	25	Carrots	27
Fallen leaves	44	Turnip tops	19
Grass clippings	40-80	Fruit wastes	35
Sesbania	18	Tobacco	13
Neem cake	5	**Forest wastes**	
Animal shed wastes		Leaves	40-80
Cow dung	19	Raw sawdust	208
Buffalo dung	19	Rotted sawdust	128
Sheep dung	29		
Horse dung	24		
Pig dung	13		

Appendix-V

SOME IMPORTANT FERTILIZER MANUFACTURERS

1. Fertilizer Corporation of India (FCI)
2. Hindustan Fertilizer Corporation (HFC)
3. National Fertilizer Limited (NFL)
4. Indian Farmers Fertilizer Co-operative Ltd. (IFFCO)
5. Gujarat State Fertilizer Company (GSFC)
6. Gujarat Narmada Valley Fertilizer Company (GNFC)
7. Indian Explosives Ltd. (IEL)
8. Zuari Agro Chemicals Ltd. (ZACL)
9. Madras Fertilizers Ltd. (MFL)
10. Sri Ram Fertilizers and Chemicals (SFC)
11. Mangalore Chemicals and Fertilizers (MCF)
12. Fertilizers and Chemicals Travancore Ltd. (FACT)
13. Southern Petrochemicals Industries Corporation Ltd. (SPIC)
14. Dharmsi Morarji Chemical Company Ltd. (DMCC)
15. Corromondal Fertilizer Ltd. (CFL)
16. Krishik Bharti Cooperative Ltd. (KRIBHCO)
17. Rashtriya Chemicals and Fertilizers Ltd. (RCF)
18. Hindustan Zinc Ltd. (HZL)
19. Hindustan Copper Ltd. (HCL)
20. Hari Fertilizers.

Appendix-VI

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